Use of technology and networking:

how do they change our brain

Conceptual map

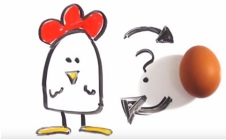
IDENTITY and SOCIAL RELATIONSHIP

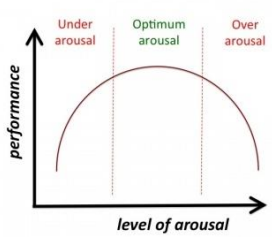
Change of the world

Change of the brain

FREE TIME

enlarged ventral striatum





LEARNING

AGGRESSION

Summary

- Change of the World: from 3D to 2D
- How our brain works and changes
- Effects of the digital world on identity and relationship
- **Effects of the digital world on free time and aggressivity**
- Effects of the digital world on memory and learning

Time on videogames

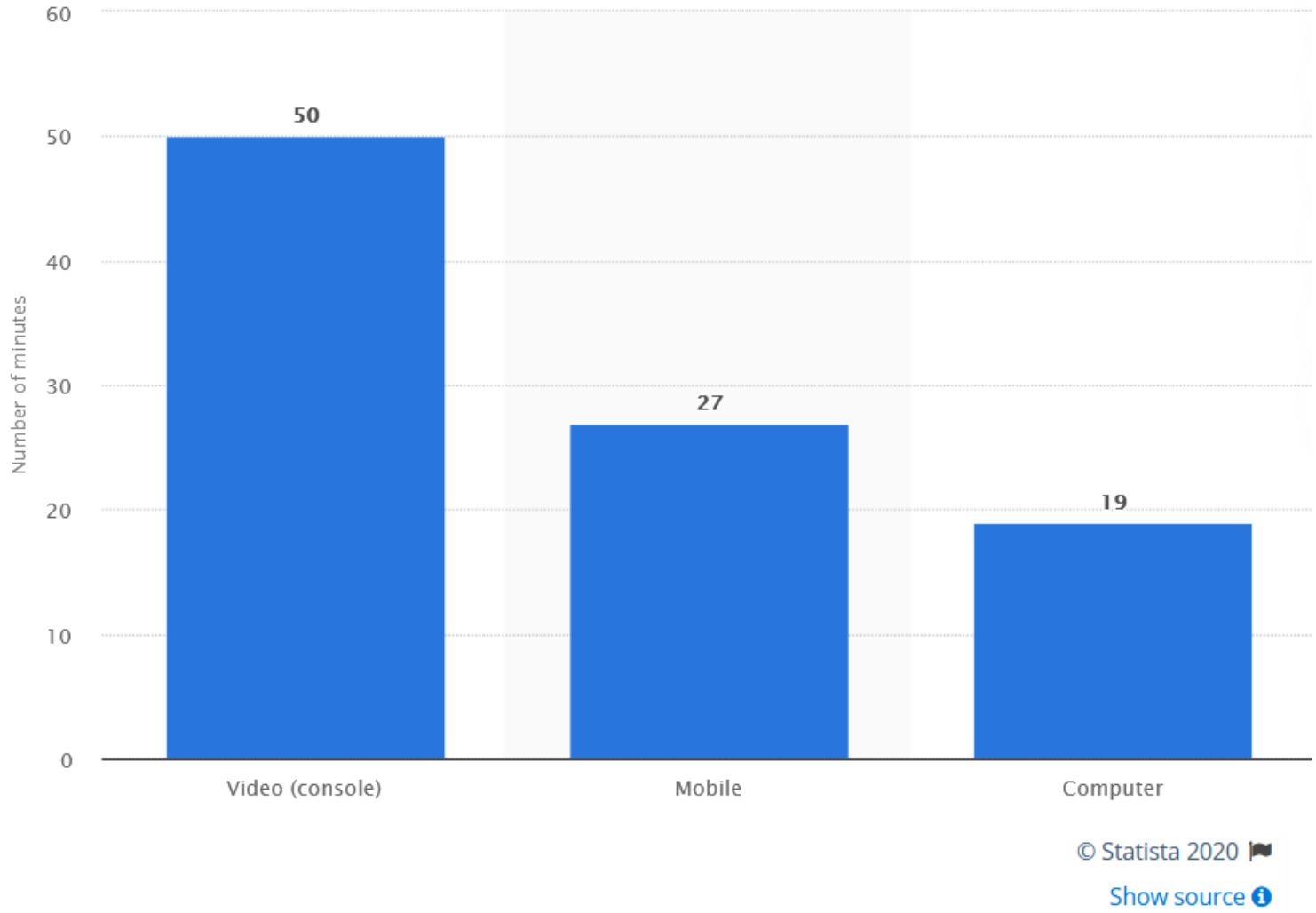
- A 2012 study of U.S. adolescents reported that boys between the ages of ten and thirteen were **playing** on average a staggering **forty-three hours** a week (although, admittedly, the number of subjects was fairly small, 184).
- Yet even conservative estimates (from 2009) indicate that the average U.S. child between the ages of eight and eighteen is spending seventy-three minutes a day recreationally in this one screen-based activity, up from twenty-three minutes in 1999.
- In a survey of U.S. youth between ages ten and nineteen, gamers spent 30 percent less time reading and 34 percent less time doing homework.

Homer et al., (2012). Gender and player characteristics in videogame play of preadolescents. *Computers in Human Behavior* 28, no. 5, 1782–1789.

Rideout, et al., (2010). *Generation M2: Media in the lives of 8-to 18-year-olds*.

Cummings and Vandewater (2007). Relation of adolescent videogame play to time spent in other activities. *Archives of Pediatrics & Adolescent Medicine* 161, no. 7, 684.

Time on videogames



Videogame and the brain

What’s going on in our brain when we play videogames?

Videogame and the brain

- Aviv Weinstein at the Hadassah Medical Organization in Jerusalem believes that the **craving** for **online gaming** and the **craving** for **substance dependence** could well share the same neurobiological mechanism.

Weinstein, A., and Lejoyeux, M. (2010). Internet addiction or excessive Internet use. *American Journal of Drug and Alcohol Abuse* 36, no. 5, 277–283.

Craving hypothesis

- N = 9 abstinent “ecstasy” users and 8 control subjects
- They were scanned at baseline and after performing on a motorbike riding computer game while imaging **dopamine** release in vivo with single photon emission computed tomography (SPECT)

The American Journal of Drug and Alcohol Abuse, 36:268–276, 2010

ISSN: 0095-2990 print / 1097-9891 online
DOI: 10.3109/00952990.2010.491879

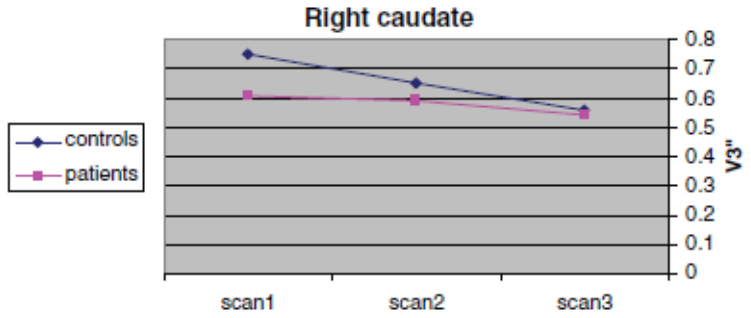
Computer and Video Game Addiction—A Comparison between Game Users and Non-Game Users

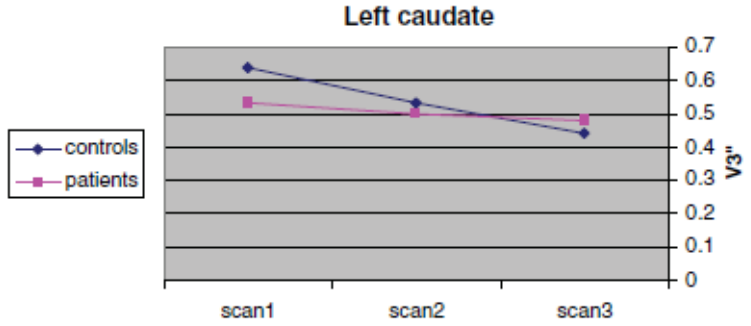
Aviv Malkiel Weinstein, Ph.D.
Department of Medical Biophysics and Nuclear Medicine, Hadassah Hospital, Ein Kerem, Jerusalem, Israel, and Department of Nuclear Medicine, Sourasky Medical Center, Tel Aviv, Israel

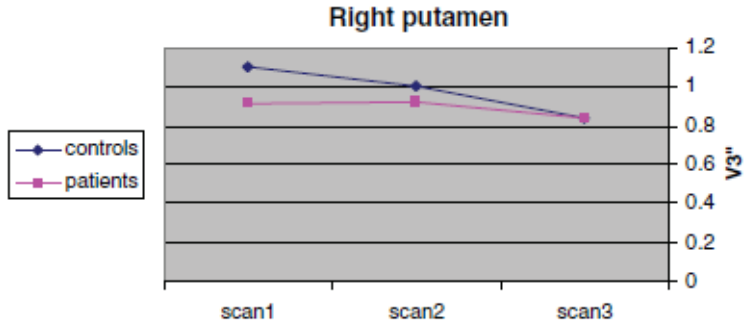
Weinstein, A. M. (2010). Computer and videogame addiction: A comparison between game users and non-game users. *American Journal of Drug and Alcohol Abuse* 36, no. 5, 268–276.

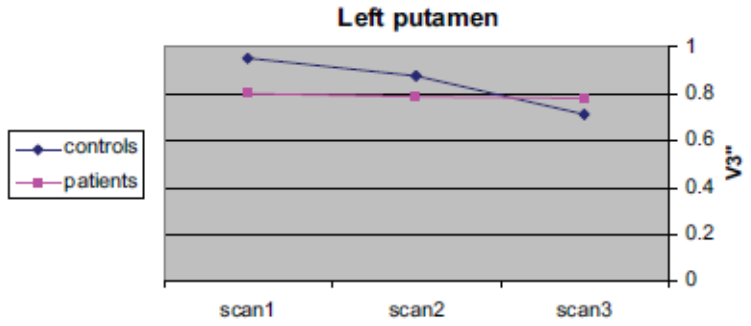
Craving hypothesis

- The brain imaging study showed that **healthy control subjects** had **reduced dopamine D2 receptor occupancy of 10.5%** in the **caudate** after playing a motorbike riding computer game compared with baseline levels of binding consistent with **increased release** and binding to its receptors.
- Ex-chronic "**ecstasy**" users showed **no change in levels of dopamine D2** receptor occupancy after playing this game.



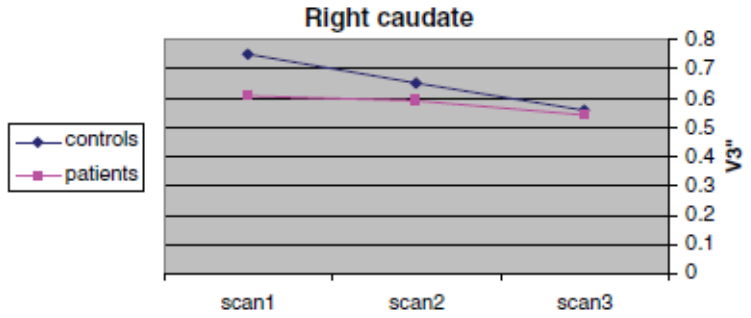


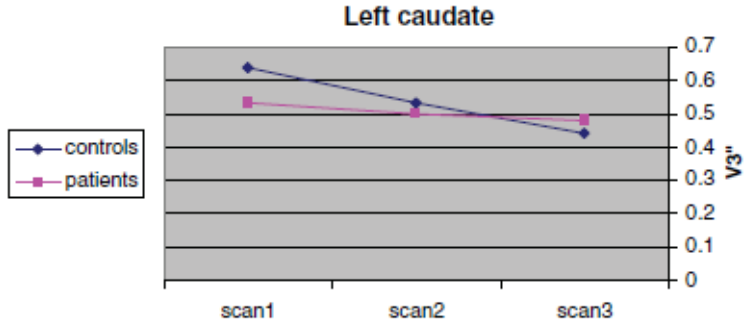


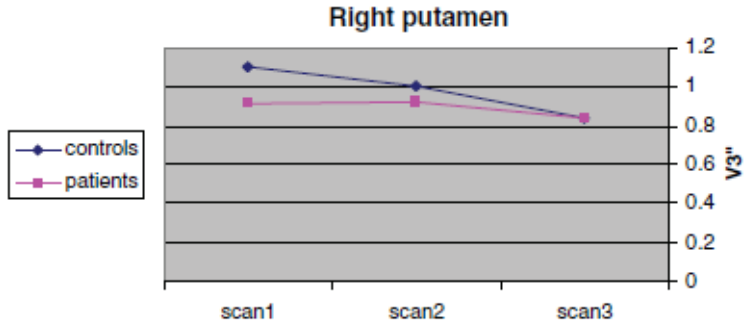


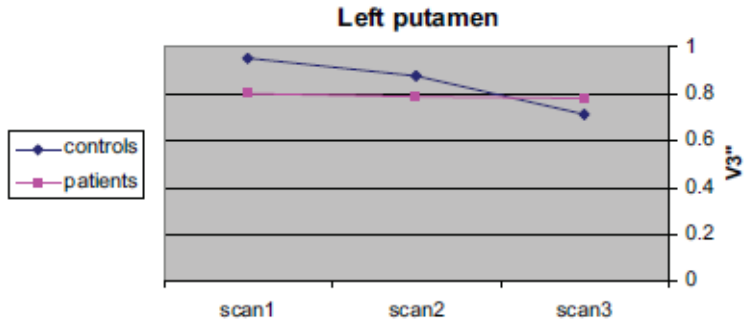
Craving hypothesis

- For the nonaddicts experiencing the thrill of gaming, **there was an increase in the release of dopamine** that "**desensitized**" its receptors.
- But the brains of the Ecstasy addicts told a different story. **Here chronic use of the drug had accustomed the brain to vast amounts of dopamine**. The videogames added no excitement because they worked via the same common mechanism.
- It seems that as far as the brain was concerned, taking Ecstasy and gaming were comparable experiences









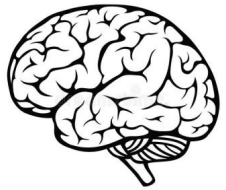
Craving hypothesis

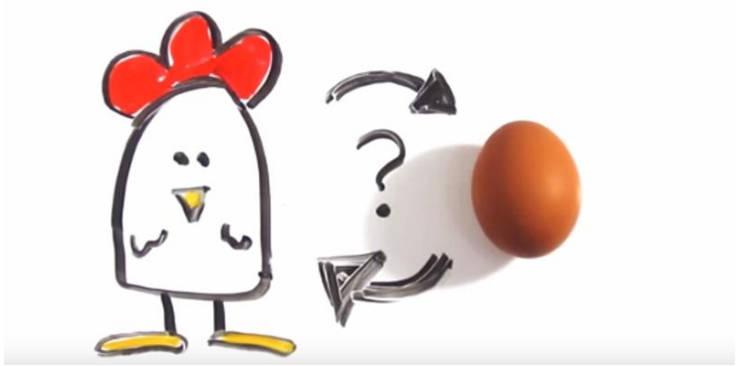
- In **young gamers**, brain imaging shows an enlargement of the area of the brain (the ventral striatum) where the neurotransmitter dopamine is released.
- Interestingly enough, a similar feature is also characteristic of the brains of **pathological gamblers**, who suffer from another behavioral addiction.
- So it seems that whether we're talking about addiction to drugs, gambling, or videogames, all three conditions are linked to excessive dopamine release in the ventral striatum.

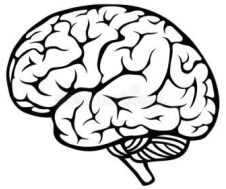
Kühn et al., (2011). The neural basis of gaming. *Translational Psychiatry* 1, no. 11, e53.

Chicken and eggs dilemma

individuals with brains that happen to have an enlarged **ventral striatum** are **predisposed** to **gaming**







excessive **gaming** has literally left its **mark** on the **brain**

Chicken and eggs dilemma

- Let's start with the chicken: that gaming, as with all life experiences, leaves its mark on the impressionable, plastic brain.

- According to Kuhn et al., the more time spent playing, the more pronounced the expansion of the striatum. This suggests the former caused the latter.

- The higher the video-game hours → the higher the striatal volume

Kühn et al., (2011). The neural basis of gaming. *Translational Psychiatry* 1, no. 11, e53.

Citation: Transl Psychiatry (2011) e53, doi:10.1038/tp.2011.53

www.nature.com/tp

Gaming → mark in the brain

The neural basis of video gaming

S Kühn[1,2,3], A Romanowski[2], C Schilling[2], R Lorenz[2], C Mörsen[2], N Seiferth[2], T Banaschewski[4], A Barbot[5], GJ Barker[6], C Büchel[7], PJ Conrod[6], JW Dalley[8,9], H Flor[10], H Garavan[11], B Ittermann[3], K Mann[12], J-L Martinot[13,14], T Paus[15,16,17], M Rietschel[18], MN Smolka[19,20], A Ströhle[1], B Walaszek[3], G Schumann[6], A Heinz[2], J Gallinat[2] and The IMAGEN Consortium

- N = 154, 14-years-old
- Division between: frequent and infrequent

- Moreover, they assessed the Monetary Incentive Delay (MID) task during fMRI imaging and a Gambling Task (CGT)
  - During the **MID task**, participants see cues that indicate that they may win or not win money, then wait for a variable anticipatory delay period, and finally respond to a rapidly presented target with a button press to try to either win or avoid losing money.
  - During the **CGT**, participants made simple probabilistic judgments between two mutually exclusive outcomes, and then placed a bet on their confidence in that decision

Gaming → mark in the brain

Results:

- **higher left** striatal grey matter volume when comparing **frequent** against infrequent video game players
- **higher activity during loses**

Conclusion:

- The key finding of higher volume in left ventral striatum associated with frequent video game playing is in conceptual accordance with findings of **enhanced dopamine release** during **video game playing** and **excessive gambling** in Parkinson's patients due to dopaminergic medication.

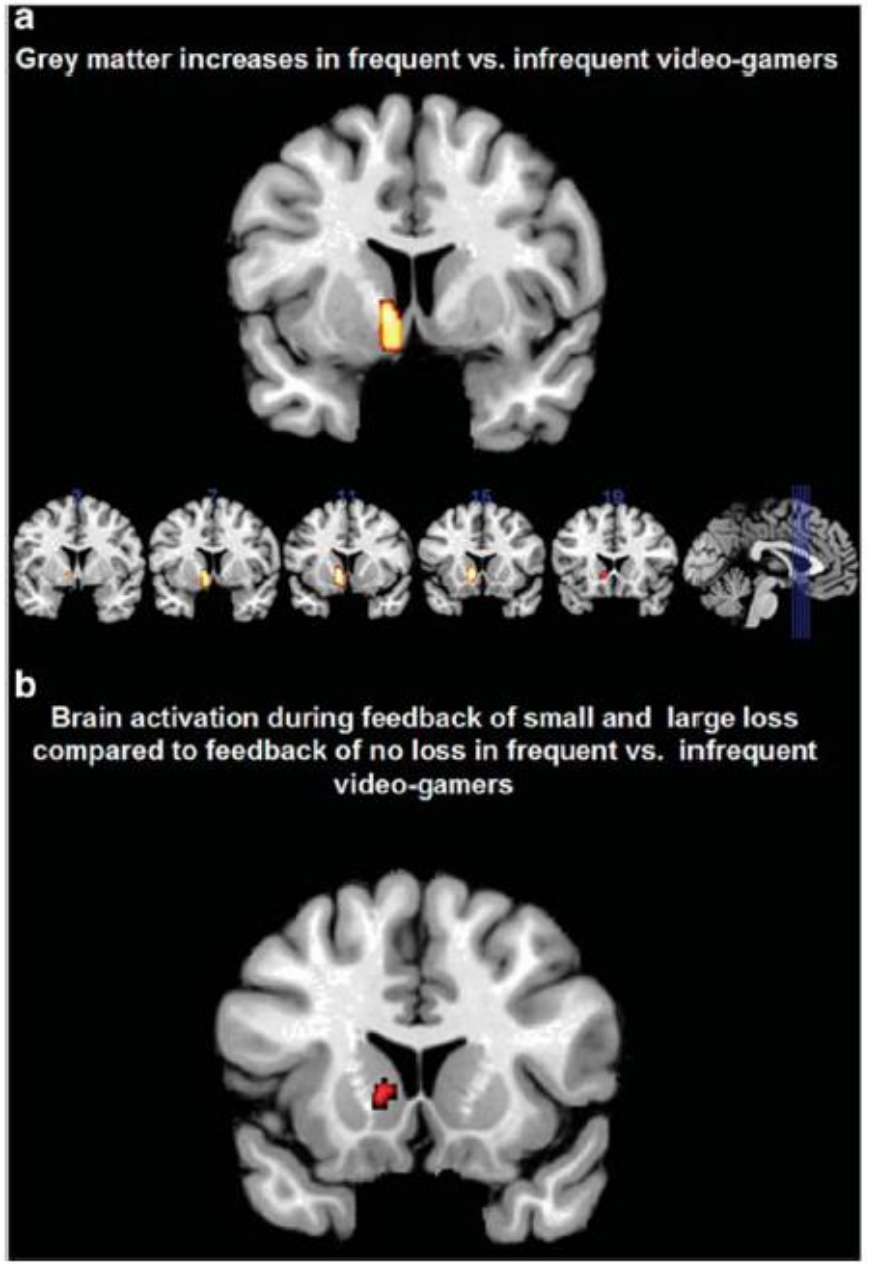


Figure 1 (a) Higher grey matter volume in frequent vs infrequent video game players in left ventral striatum, (b) higher blood oxygen-level-dependent activity in frequent vs infrequent video game players during feedback of small or large loss compared with feedback of no loss.

Gaming → mark in the brain

- Considering the CGT task → negative correlation between the gray matter volume in the left ventral striatum and the deliberation time in the CGT

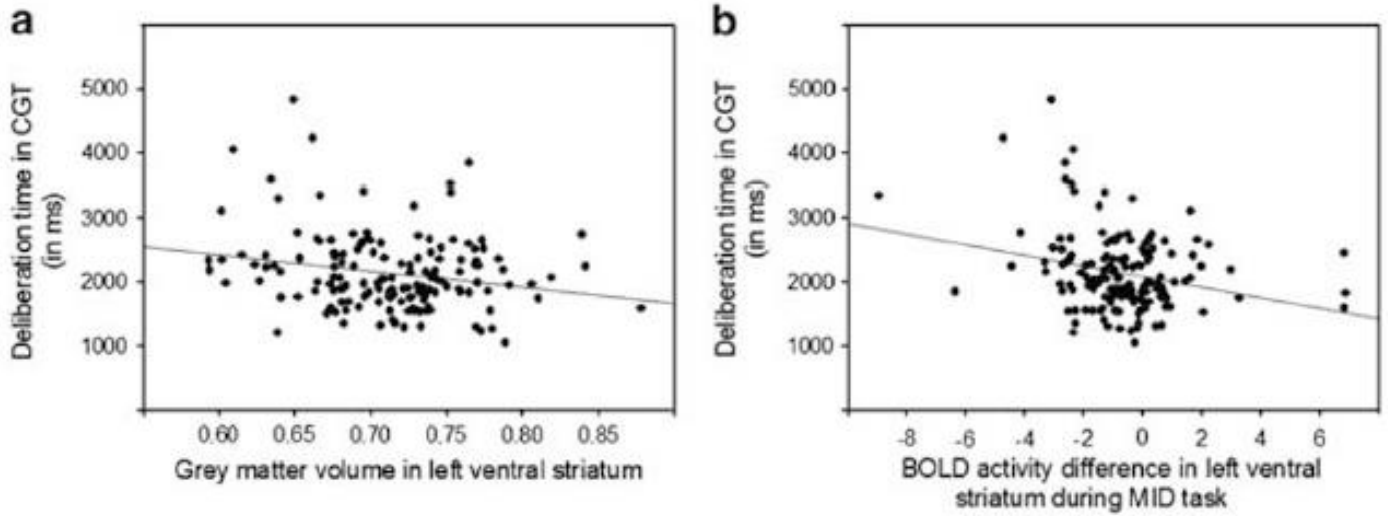


Figure 2 Scatter plot displaying the negative correlation between deliberation time in the Cambridge Gambling Task (CGT) and (**a**) grey matter volume in left ventral striatum and (**b**) blood oxygen-level-dependent (BOLD) signal difference between feedback of loss vs feedback of no loss in the Monetary Incentive Delay (MID) task.

Gaming → mark in the brain

- Considering the MID task → **frequent** compared with infrequent video game players showed **enhanced activity** during feedback of loss compared with no loss

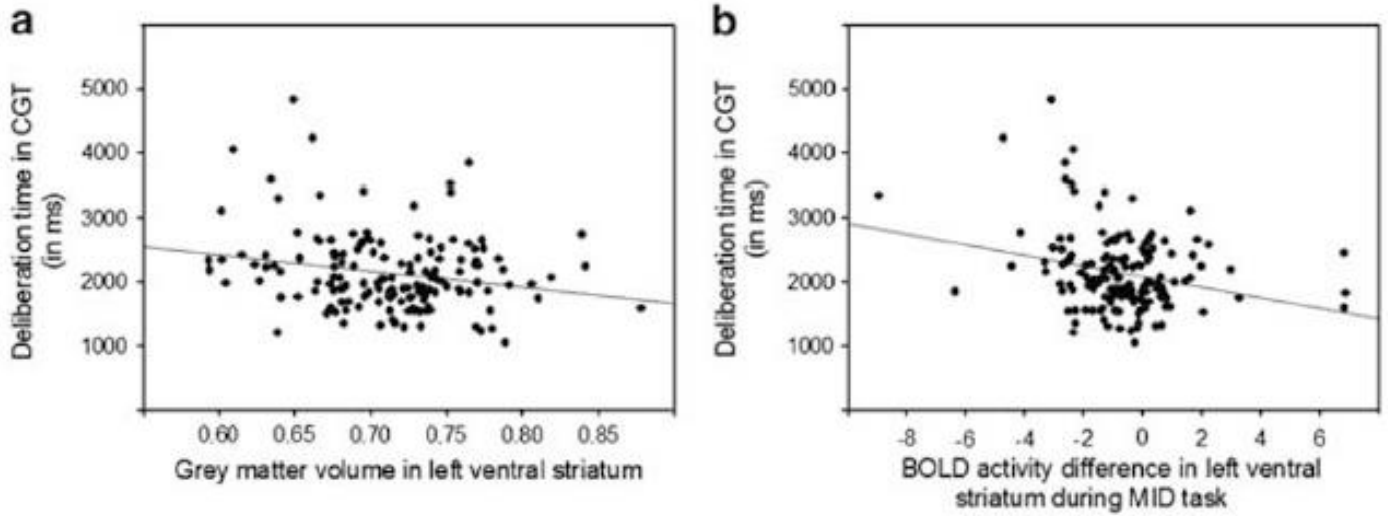


Figure 2 Scatter plot displaying the negative correlation between deliberation time in the Cambridge Gambling Task (CGT) and (**a**) grey matter volume in left ventral striatum and (**b**) blood oxygen-level-dependent (BOLD) signal difference between feedback of loss vs feedback of no loss in the Monetary Incentive Delay (MID) task.

Chicken and eggs dilemma

- Then there's the egg: the idea that a preexisting brain state might predispose individuals to compulsive gaming

- Kirk Erickson at the University of Illinois found a correlation between the **volume** of a key brain area, the **dorsal striatum**, and later **training success** in a videogame

Erickson et al., (2010). Striatal volume predicts level of videogame skill acquisition. *Cerebral Cortex* 20, no. 11, 2522–2530

Chicken and eggs dilemma

- Erickson has also described a link, again seen with imaging, between **activation of the striatum before training** and **subsequent later skill acquisition** during gaming.
- These findings highlight the importance of the striatum, a rich source of dopamine, and how this might be consistent with the idea that **some brains are more susceptible to the lure of games.** Individuals who happen to have a larger striatum might experience gaming as more rewarding in the first place.
- This neurological setup, in turn, could facilitate skill acquisition and lead to further rewards from playing.

Erickson et al., (2010). Striatal volume predicts level of videogame skill acquisition. *Cerebral Cortex* 20, no. 11, 2522–2530

Big striatum → more videogame

Cerebral Cortex November 2010;20:2522-2530
doi:10.1093/cercor/bhp293
Advance Access publication January 20, 2010

Striatal Volume Predicts Level of Video Game Skill Acquisition

Kirk I. Erickson[1], Walter R. Boot[2], Chandramallika Basak[3,4], Mark B. Neider[3,4], Ruchika S. Prakash[3,4], Michelle W. Voss[3,4], Ann M. Graybiel[5,6], Daniel J. Simons[3,4], Monica Fabiani[3,4], Gabriele Gratton[3,4] and Arthur F. Kramer[3,4]

[1]Department of Psychology, University of Pittsburgh, Pittsburgh, PA 15260, USA, [2]Department of Psychology, Florida State University, Tallahassee, FL 32306, USA, [3]Department of Psychology, University of Illinois, Champaign-Urbana, IL 61820, USA, [4]Beckman Institute for Advanced Science and Technology, University of Illinois, Urbana, IL 61801, USA, [5]McGovern Institute for Brain Research, Massachusetts Institute of Technology, Cambridge, MA 02139, USA and [6]Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139, USA

- N = 42 (age 15-28)
- Infrequent players (< 3 hours of video games a week during the 2 years prior to the study)
- Participants were given instructions about the Space Fortress game and then, before game training, completed an MRI session
- They were then given 20 h of Space Fortress game training

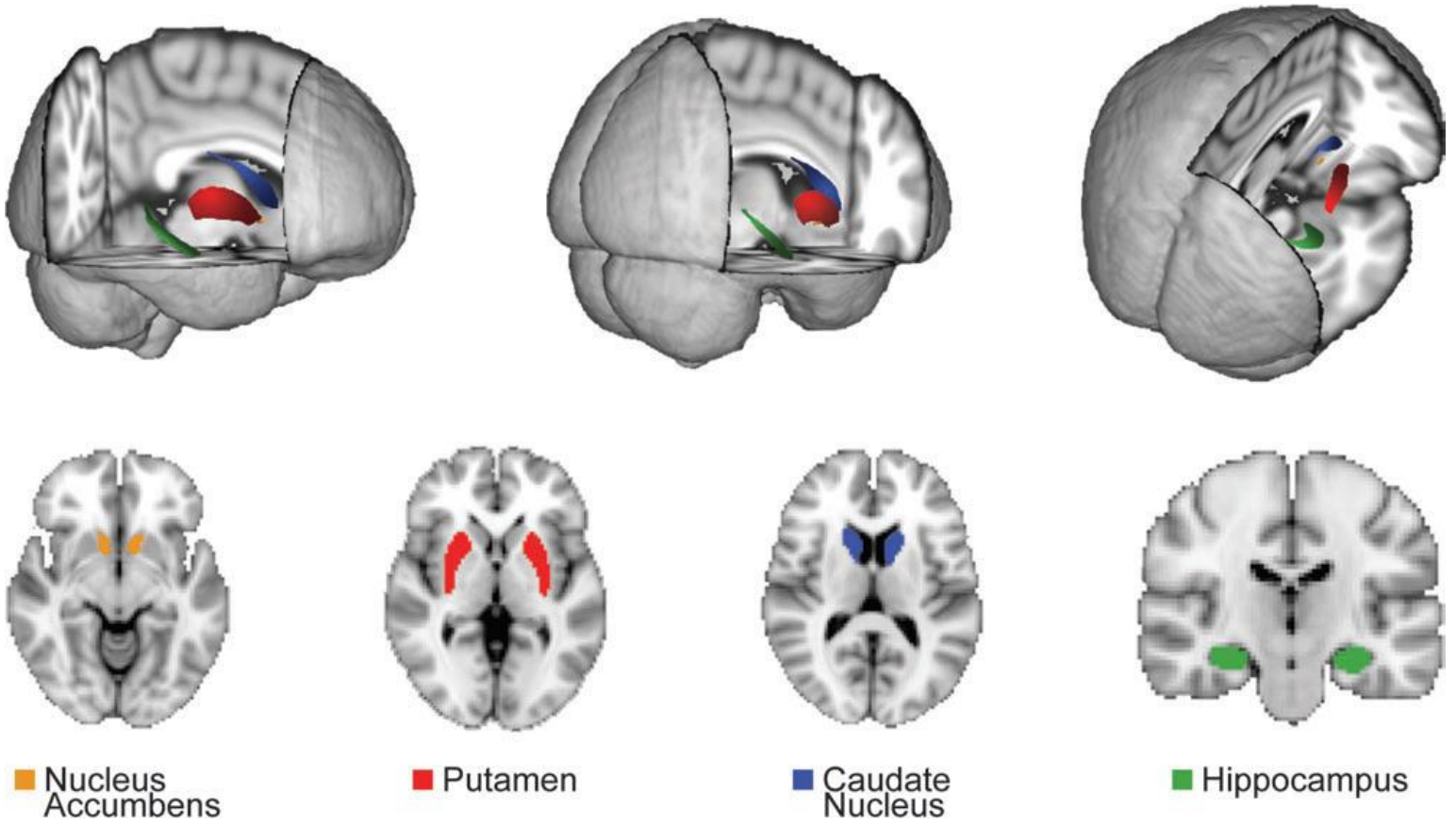
Big striatum → more videogame

- The Space Fortress game requires players to navigate their ship with precise control using a joystick.
- The ship moves in an environment, and players can rotate the ship by moving the joystick left or right or by applying a thrust by pushing forward on the joystick.
- The ship has no braking system, so that in order for players to slow or stop the ship, they must rotate it so that it faces the direction opposite to its current direction of motion and apply a thrust.
- This requirement makes control of the ship a challenging and demanding task.

Big striatum → more videogame

RESULTS:

- hippocampal volumes did not predict learning improvement but **striatal volumes** did.
- The volumes of the **dorsal striatum** predicted improvement in performance.
- Both ventral and dorsal striatal volumes predicted early acquisition rates.



Striatum: the key area of the dilemma

- Striatum →structure divided into 2 parts: an upper (dorsal) zone and a lower (**ventral**) one. The latter **releases more dopamine** than the former
- DORSAL STRIATUM → the dorsal striatum **coordinates sensorimotor** functions for **attaining a goal**
- VENTRAL STRIATUM → dopamine released from the ventral part ***enhances the impact of the actual reward*** that then ensues

Drevets et al., (1999). PET measures of amphetamine-induced dopamine release in ventral versus dorsal striatum. *Neuropsychopharmacology* 21, no. 6, 694–709.

Robbins et al., (1992). Functions of dopamine in the dorsal and ventral striatum. *Seminars in Neuroscience* 4, no. 2, 119–127.

Striatum: the key area of the dilemma

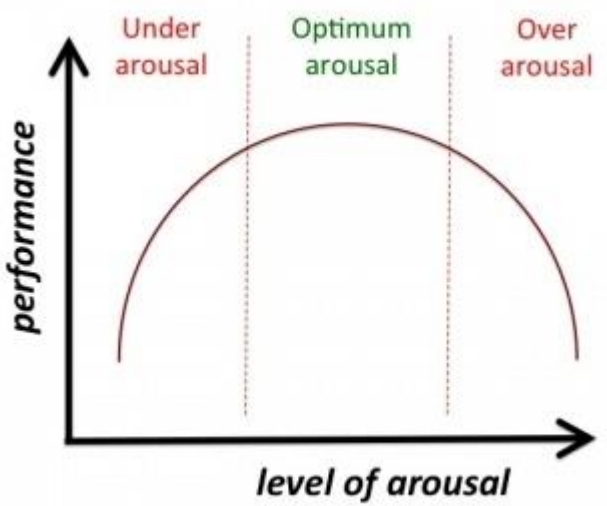
So one way of resolving the chicken-and-egg problem might be to say that a brain predisposed to effective sensorimotor coordination, with an active dorsal striatum, will have a predisposition for gaming, while it is the games themselves that change the way the ventral striatum reacts to reward.

Drevets et al., (1999). PET measures of amphetamine-induced dopamine release in ventral versus dorsal striatum. *Neuropsychopharmacology* 21, no. 6, 694–709.
Robbins et al., (1992). Functions of dopamine in the dorsal and ventral striatum. *Seminars in Neuroscience* 4, no. 2, 119–127.

Dopamine as crucial contributor

- A second way to solve the chicken-eggs problem is to consider the **dopamine**.

- Neuroscientists at Hammersmith Hospital in London have shown that **playing videogames** directly results in release of this **neurotransmitter**.
- Raised levels of dopamine are consistently linked to various brain states relating to reward, *addiction and* ***arousal***.
- Different studies investigated the role of arousal and individual's capacity for excitement.



Metcalf and Pammer (2014). Sub-types of gaming addiction: Physiological arousal deficits in addicted gamers differ based on preferred genre. *European Addiction Research* 20, no. 1,

Arousal of different videogames

- One investigation found **different patterns of arousal** in **different types of gamers**.
- Those who *played excessive* amounts of **first-person shooter videogames** had significantly **higher levels of arousal during gaming**, which dropped off immediately after gaming.

Metcalf and Pammer (2014). Sub-types of gaming addiction: Physiological arousal deficits in addicted gamers differ based on preferred genre. *European Addiction Research* 20, no. 1,

Arousal of different videogames

- MMORPG (Massive[ly] Multiplayer Online Role-Playing Game) players who gamed **excessively** displayed significant **decreases** in **physiological arousal**, which rose again immediately after gaming.
- Meanwhile, MMORPG players who **didn't play excessively** showed normal increases in arousal during gaming and then reached a plateau after their session.

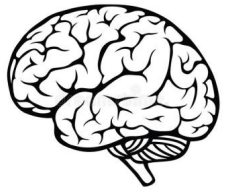
Arousal of different videogames vs gambling

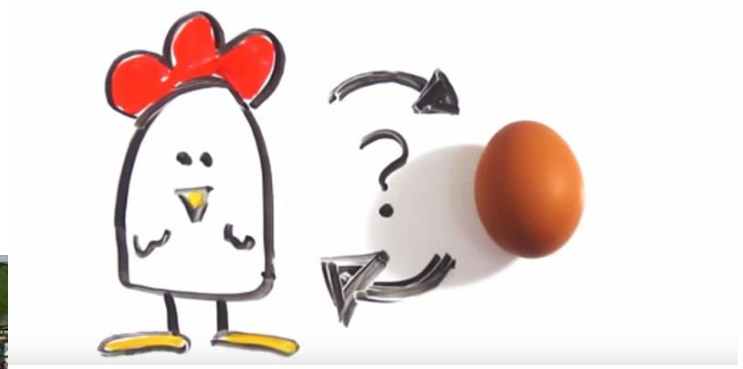
- These **differences** in **arousal** for **gamers** are comparable to those reported in the scientific literature on **pathological gambling**.

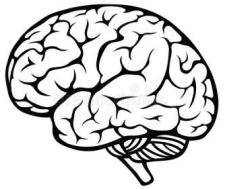
- There are the **thrill-seeking**, impulsive addicts who take stimulating substances or engage in **high-risk behaviors**; by contrast, there are the **escapists**, the often **depressed** addicts who are not seeking high arousal.

Chicken and eggs complication applies

these disturbances in arousal regulation could be either a cause of gaming addiction







Or a consequence of it

Videogames and rewards

- What finally determines an individual's level of arousal and whether he or she becomes addicted to one or another type of videogame?

- How can we solve the dilemma?

- It is impossible to tease out a cause-and-effect sequence of events as the brain interacts with the environment, and therefore it is hard to predict with any accuracy whether someone will become addicted to videogames.
- More plausible view would be that what goes on in the brains of those addicted to videogames is not **qualitatively** different but rather **quantitatively** different from what happens in the brains of those who are less obsessive.

Videogames and rewards

- MMORPGs have been studied because excessive gaming is most commonly seen in MMORPGs
- The reward structure built into the game influences the development of excessive gaming
- MMORPGs have intricate reward systems built into the games, with gamers constantly trying to reach the next level

Videogames and rewards

- Moreover the social interaction with other players appears to be the real extra hook.

- Perhaps the appeal is that the player is now not just playing a game but playing out an idealized life that is simultaneously exciting and safe, both physically and mentally

From free time to aggression

A crucial point related to videogames is related to aggression

Is there a link between aggression and videogames?

???

???

Violent videogames

Especially “realistic” video games

Increase aggression

Increase aggression in real life

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

Developmental Psychology
2007, Vol. 43, No. 4, 1038–1044

0012-1649/07/$12.00 DOI: 10.1037/0012-1649.43.4.1038

I Wish I Were a Warrior: The Role of Wishful Identification in the Effects of Violent Video Games on Aggression in Adolescent Boys

Elly A. Konijn and Marije Nije Bijvank
VU University Amsterdam

Brad J. Bushman
University of Michigan and VU University Amsterdam

- This study tested the hypothesis that violent video games are especially likely to increase aggression when players identify with violent game characters
- N = 112 Dutch adolescent boys with low education ability
- were randomly assigned to play a realistic or fantasy violent or nonviolent video game

3 violent–realistic games (*America's Army* [U.S. Army], *Killzone* [Sony Computer Entertainment Europe], and *Max Payne* [Rock Star Games])

3 violent–fantasy games (*Doom 3* [id Software], *Quake* [id Software], and *Metroid Prime* [Nintendo])

3 **nonviolent–realistic games** (*Pro Evolution Soccer* [Konami], *The Sims 2* [EA Games], and *Tony Hawk's Underground* [Activision]),

3 nonviolent–fantasy games (*Mario Kart* [Nintendo], *Mario Sunshine* [Nintendo], and *Final Fantasy* [Square Enix]).

Konijn, E. A., Nije Bijvank, M., and Bushman, B. J. (2007). I wish I were a warrior: The role of wishful identification in the effects of violent videogames on aggression in adolescent boys. Developmental Psychology 43, no. 4, 1038–1044. doi:10:1037/0012–1649:43.4:1038

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

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Elly A. Konijn and Marije Nije Bijvank
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→ MEASURE OF AGGRESSION

- After the videogame, participants competed with an ostensible (pretended) partner on a reaction time task in which the winner could blast the loser with loud noise through headphones, which served as the measure of aggression.
- Participants were told, wrongly, that high noise levels could cause permanent hearing damage.

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

→ MEASURE OF AGGRESSION

RESULTS: the most aggressive participants turned out to be those who played a violent game. These participants used noise levels that they believed were loud enough to cause permanent hearing damage to their partners, even though their partners had not provoked them

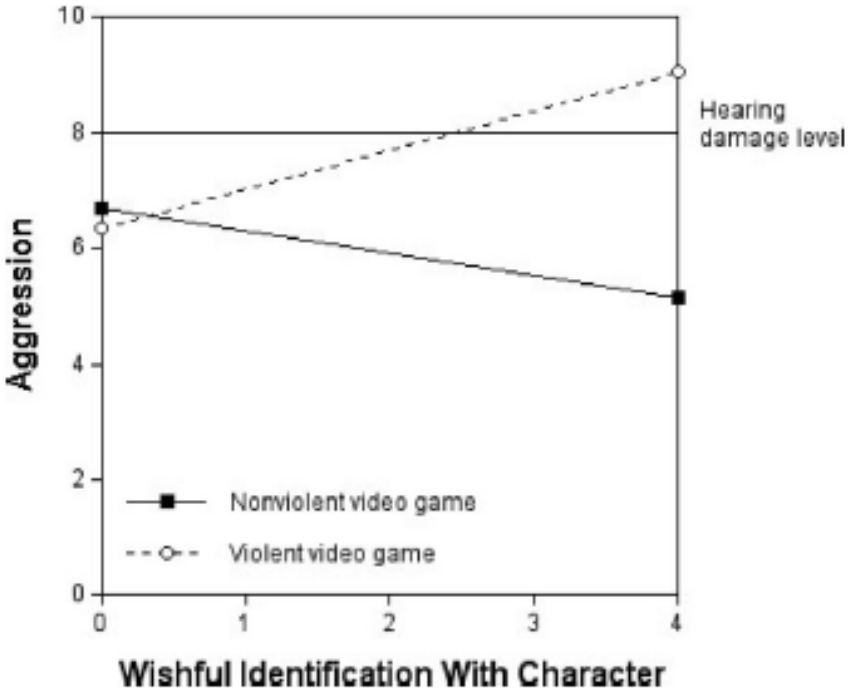

Figure 2. Relationship between wishfully identifying with violent and nonviolent characters in video games and aggression levels. Aggression was defined as the level of noise participants set for their ostensible partner on the first trial of the competitive reaction time task (before they had heard any noise themselves). Noise levels ranged from Level 1 (60 dB) to Level 10 (105 dB), in 5-dB increments. A nonaggressive no-noise option was also given (Level 0), although no boy chose Level 0. Participants were told that Levels 8–10 could cause permanent hearing damage to their "partner." Note that participants who strongly wished to be like violent video game characters exceeded Level 8 noise, even though they believed it could have permanently damaged a partner's ears.

Konijn, E. A., Nije Bijvank, M., and Bushman, B. J. (2007). I wish I were a warrior: The role of wishful identification in the effects of violent videogames on aggression in adolescent boys. Developmental Psychology 43, no. 4, 1038–1044. doi:10:1037/0012–1649:43.4:1038

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

- Craig Anderson, professor and chair of psychology at Iowa State University and a leading researcher in the field of videogame violence, is concerned that while violent games do not cause extreme, criminal-level violent behavior, they do enhance **low-level aggression**.

- Anderson's suggestion is that the link between aggression and gaming is an indirect and generalized association. Indeed, it's quite plausible that subconscious leanings toward violence could be transformed into overtly conscious ones via gaming and through **repetition** could become automatic, the default mode.

Anderson et al, (2010). Violent videogame effects on aggression, empathy, and prosocial behavior in Eastern and Western countries: A meta-analytic review. *Psychological Bulletin* 136, no. 2, 151.

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

- The problem could be the repetition →since we learn...

- More recently, videogame researcher Douglas Gentile has echoed this theme, pointing out that “whatever we practice repeatedly affects the brain and if we practice aggressive ways of thinking, feeling and reacting, then we will get better at those

Anderson et al, (2010). Violent videogame effects on aggression, empathy, and prosocial behavior in Eastern and Western countries: A meta-analytic review. *Psychological Bulletin* 136, no. 2, 151.

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

- This study investigates the hostile expectation bias (i.e., tendency to perceive hostile intent on the part of others).
- N = 136 French college students
- They played either a violent or nonviolent game for 20 minutes.
- Afterwards, they read ambiguous story stems about potential interpersonal conflicts, and **listed** what they thought the main characters would do or say, think, and feel as the story continued

Journal of Experimental Social Psychology 48 (2012) 953–956

Contents lists available at SciVerse ScienceDirect

Journal of Experimental Social Psychology

journal homepage: www.elsevier.com/locate/jesp

FlashReport

Viewing the world through "blood-red tinted glasses": The hostile expectation bias mediates the link between violent video game exposure and aggression ☆

Youssef Hasan [a,*], Laurent Bègue [a], Brad J. Bushman [b,c]

[a] University Pierre Mendès-France, Grenoble, France
[b] The Ohio State University, Columbus, OH, USA

Violent videogame

Non Violent videogame

ambiguous story stems

Hasan H, Lauren B, Bushman BJ. Viewing the world through "blood-red tilted glasses". Journal of Experimental Social Psychology, 40, 2012, 953-958.

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

- Finally, participants were told that they would compete with an opponent (actually a confederate) on a 25-trial computer game in which they had to respond to a visual cue faster than their partner, with the loser receiving a noise blast through a pair of headphones.
- The intensity and duration of the noise were determined by each individual at the beginning of the trial. from60 dB (Level 1) to 105 dB (Level 10; about the same level as a smoke or fire alarm). A nonaggressive no-noise level was also offered (Level 0).
- Participants could also determine how long their opponent suffered by setting the noise duration from 0 to 5 s, in .5 s noise increments

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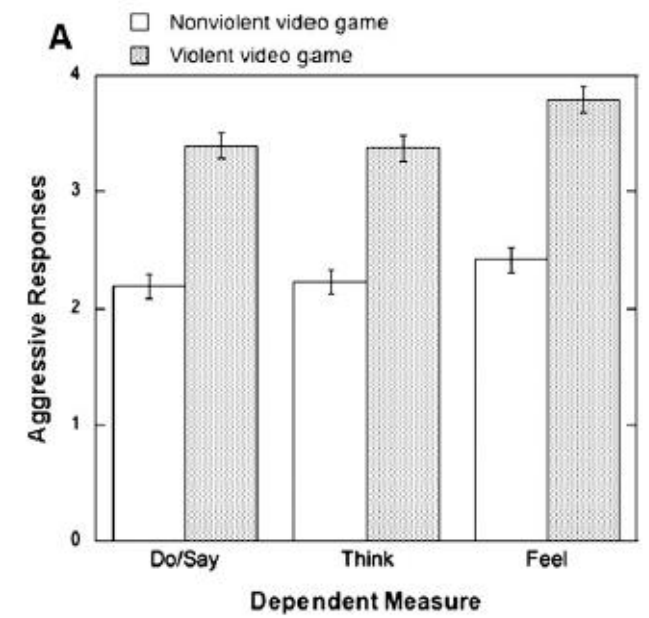
→ **MEASURE OF AGGRESSION**

Hasan H, Lauren B, Bushman BJ. Viewing the world through "blood-red tilted glasses". Journal of Experimental Social Psychology, 40, 2012a, 953-958.

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

- As hypothesized, video game violence increased the hostile expectation bias, which, in turn, increased aggression.
- Effects were larger for men than women.
- Thus one reason why violent games increase aggression is because they increase hostile expectations.



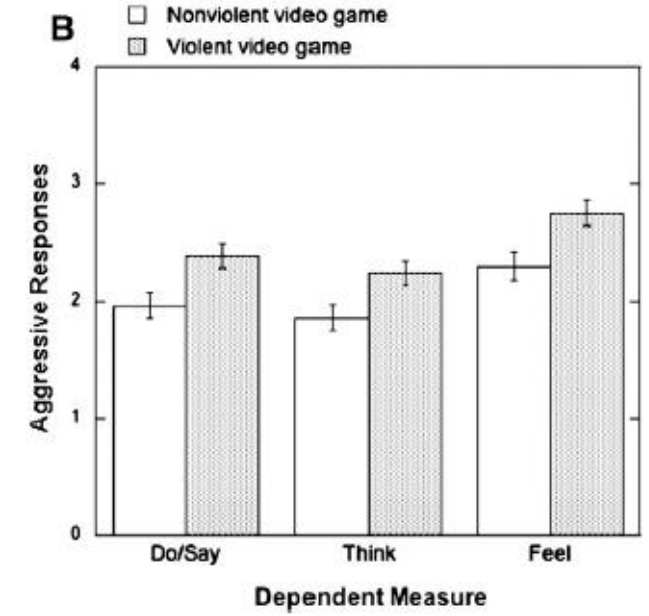


Fig. 2. *A.* Effect of videogame content on expectations of whether the main characters in the stories would do or say something aggressive, have aggressive thoughts, or feel angry inside ($N = 68$ men). Capped vertical bars denote 1 *SE*. *B.* Effect of videogame content on expectations of whether the main characters in the stories would do or say something aggressive, have aggressive thoughts, or feel angry inside ($N = 68$ women). Capped vertical bars denote 1 *SE*.

Hasan H, Lauren B, Bushman BJ. Viewing the world through “blood-red tilted glasses”. Journal of Experimental Social Psychology, 40, 2012a, 953-958.

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

- Moreover, these effects seem to increase and last for several days.

Contents lists available at SciVerse ScienceDirect

Journal of Experimental Social Psychology

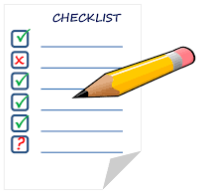
journal homepage: www.elsevier.com/locate/jesp

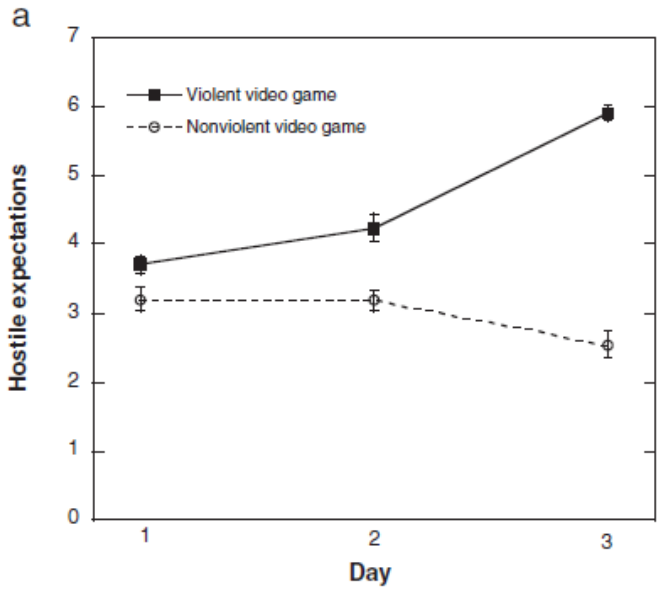
FlashReport

The more you play, the more aggressive you become: A long-term experimental study of cumulative violent video game effects on hostile expectations and aggressive behavior

Youssef Hasan [a,*], Laurent Bègue [a], Michael Scharkow [b], Brad J. Bushman [c,d]

[a] University Pierre Mendès-France, Grenoble, France
[b] University of Hohenheim, Germany
[c] The Ohio State University, USA
[d] VU University, Amsterdam, the Netherlands





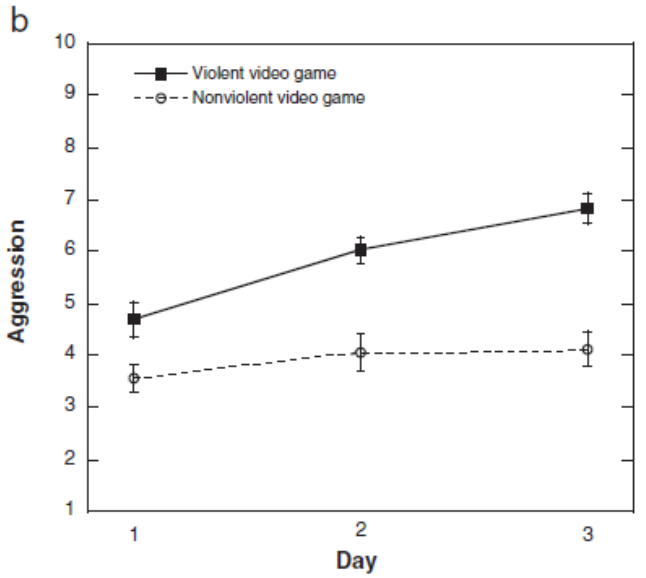


Fig. 1. a. Effect of video game content on hostile expectations over time. Capped vertical bars denote 1 standard error. b. Effect of video game content on aggressive behavior over time. Capped vertical bars denote 1 standard error.

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

AGGRESSIVE BEHAVIOR
Volume 00, pages 1–7 (2012)

Violent Video Games Stress People Out and Make Them More Aggressive

Youssef Hasan[1]*, Laurent Bègue[1], and Brad J. Bushman[2,3]

[1] University Pierre Mendès-France, Grenoble, France
[2] The Ohio State University, Columbus, Ohio
[3] VU University, Amsterdam, the Netherlands

- The present study investigates whether violent games increase aggression by inducing **stress in players**. Stress was measured using **cardiac coherence**, defined as the synchronization of the rhythm of breathing to the rhythm of the heart.
- Authors predicted that cardiac coherence would mediate the link between exposure to violent video games and subsequent aggression. Specifically, authors predicted that *playing a violent video game would decrease cardiac coherence*, and that cardiac coherence, in turn, would correlate negatively with aggression
- N = 77

Violent videogame

Non Violent videogame

ambiguous story stems

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

AGGRESSIVE BEHAVIOR
Volume 00, pages 1–7 (2012)

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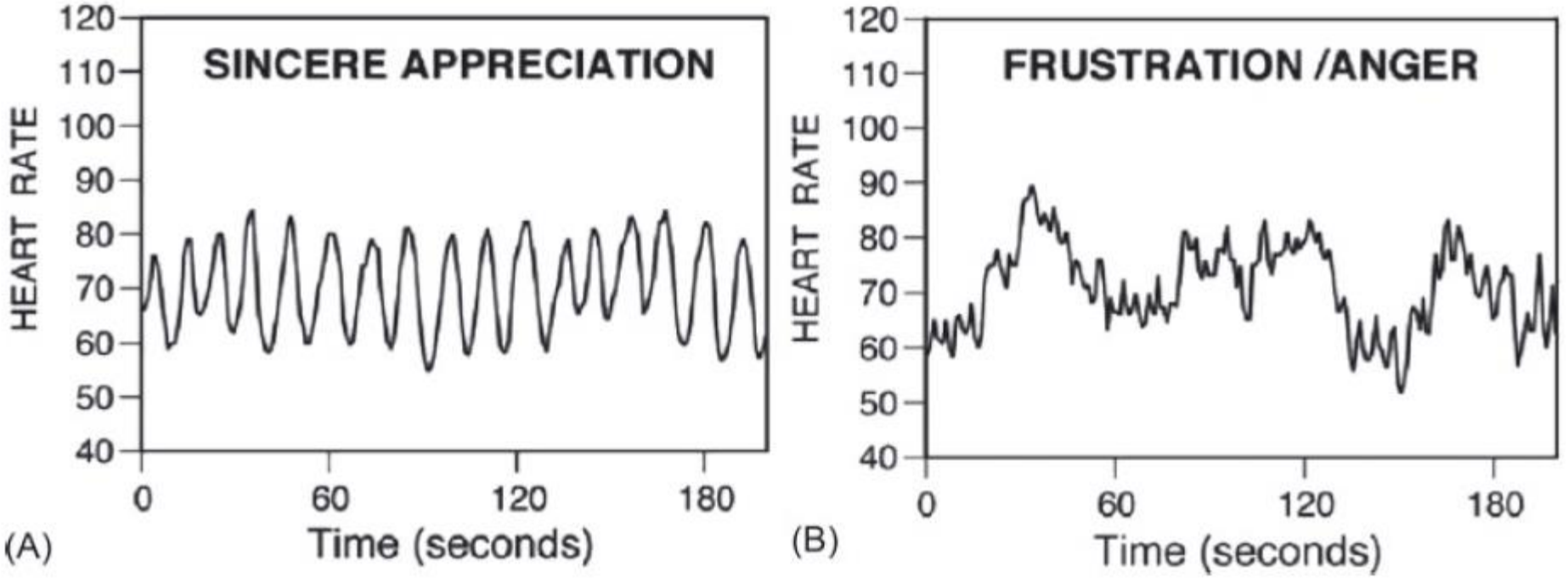

Fig. 1. (A) Cardiac variability over time in response to positive emotions. (B) Cardiac variability over time in response to negative emotions. From McCraty (2002).

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

AGGRESSIVE BEHAVIOR
Volume 00, pages 1–7 (2012)

Violent Video Games Stress People Out and Make Them More Aggressive

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[1] University Pierre Mendès-France, Grenoble, France
[2] The Ohio State University, Columbus, Ohio
[3] VU University, Amsterdam, the Netherlands

As expected, **violent video game players had lower cardiac coherence levels and higher aggression** levels than did nonviolent game players.

This research offers another possible reason why violent games can increase aggression—by inducing stress.

Cardiac coherence can be a useful tool to measure stress induced by violent video games.
Cardiac coherence has several desirable methodological features as well: it is noninvasive, stable against environmental disturbances, relatively inexpensive, not subject to demand characteristics, and
easy to use.

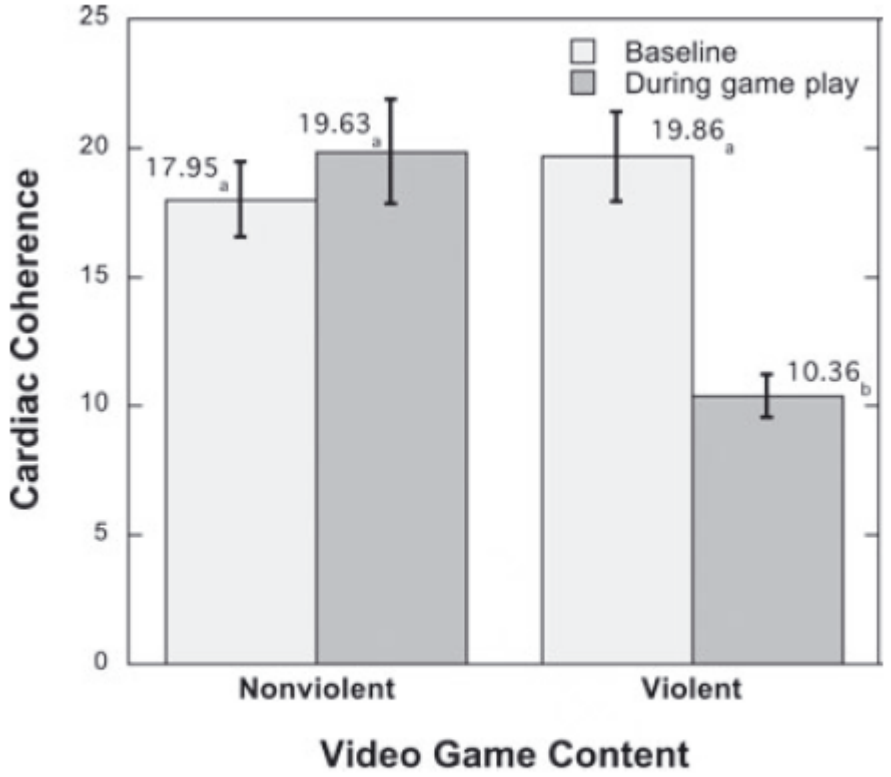


Fig. 2. Effects of violent and nonviolent video game on cardiac coherence at baseline and during game play. Means containing the same subscript are not significantly different at the .05 significance level. Capped vertical bars denote 1 standard error.

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

- The change toward a more aggressive disposition as a result of videogames does seem to be a definite global phenomenon across different cultures.
- A recent longitudinal study designed to explore the long-term effects of violent games on the mentality of American and Japanese school-age young people has shown that, in as little as three months, **high exposure to violent videogames increases physical aggression**, such as punching or kicking someone or getting into physical fights.
- Other recent, similar studies in Germany and Finland have demonstrated similar effects

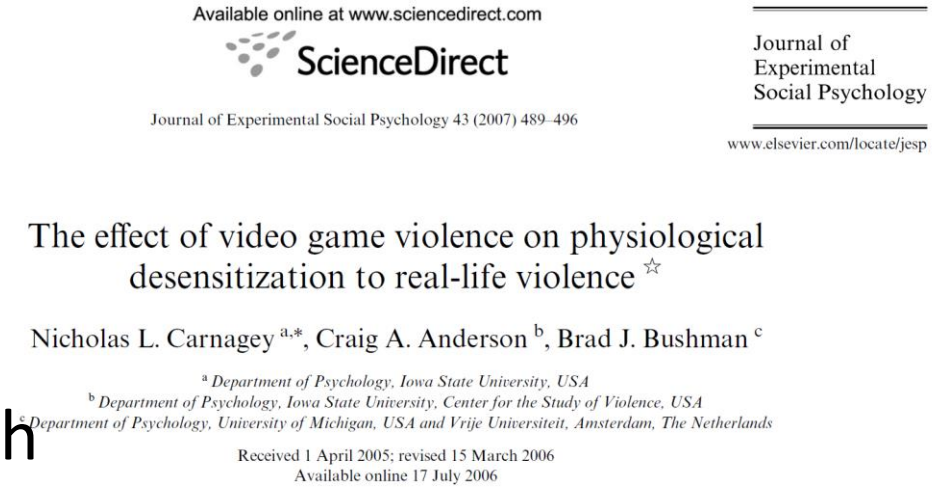
VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

- Although the systematic study of videogames is relatively new, the evidence seems strong for a link between playing videogames and an aggressive mindset. The most comprehensive meta-analysis to date has drawn on 136 papers detailing 381 independent tests of association conducted on a total of 130296 research participants, finding that violent game play led to significant increases in desensitization, physiological arousal, aggressive cognition, and aggressive behavior, while prosocial behavior decreased
- Limitations and biases → peer-reviewed scientific literature immediately criticized for a number of methodological flaws, in particular a bias in the selection of studies included, as well as allegedly trivial size effects

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

- Beyond aggressive behavior toward others, violent videogames clearly do have a demonstrable effect on the brain and body.
- Research has linked **violent videogames to changes in the fight-or-flight system** that has evolved to prepare the body for action by pumping blood around the body more quickly, putting digestion on hold, cooling down the skin with sweat, and so on.
- It seems that players can become habituated to this adrenal rush, such that living through a realistic violent experience will no longer trigger strong reaction.
- Nicholas Carnagey, a psychologist at Iowa State University, demonstrated that brief exposure to violent videogames influences activation of the Autonomic Nervous System

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS


Available online at www.sciencedirect.com
ScienceDirect
Journal of Experimental Social Psychology 43 (2007) 489–496
Journal of Experimental Social Psychology
www.elsevier.com/locate/jesp

The effect of video game violence on physiological desensitization to real-life violence ☆

Nicholas L. Carnagey [a,*], Craig A. Anderson [b], Brad J. Bushman [c]

[a] Department of Psychology, Iowa State University, USA
[b] Department of Psychology, Iowa State University, Center for the Study of Violence, USA
[c] Department of Psychology, University of Michigan, USA and Vrije Universiteit, Amsterdam, The Netherlands

Received 1 April 2005; revised 15 March 2006
Available online 17 July 2006

- INTRODUCTION of the STUDY: Past research shows that violent video game exposure increases aggressive thoughts, angry feelings, physiological arousal, aggressive behaviors, and decreases helpful behaviors.
- However, no research has experimentally examined violent video game effects on physiological desensitization, defined as showing less physiological arousal to violence in the **real world** after exposure to video game violence in the virtual world.

Carnagey et al., (2007). The effect of videogame violence on physiological desensitization to real-life violence. *Journal of Experimental Social Psychology* 43, no. 3, 489–496

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

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Received 1 April 2005; revised 15 March 2006
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- N = 257 college students
- Divided in 2 groups: violent or nonviolent video games
- They played video games for 20m
- Next, participants watched a 10-min videotape containing scenes of real-life violence while heart rate (HR) and galvanic skin response (GSR) were monitored

Carnagey et al., (2007). The effect of videogame violence on physiological desensitization to real-life violence. *Journal of Experimental Social Psychology* 43, no. 3, 489–496

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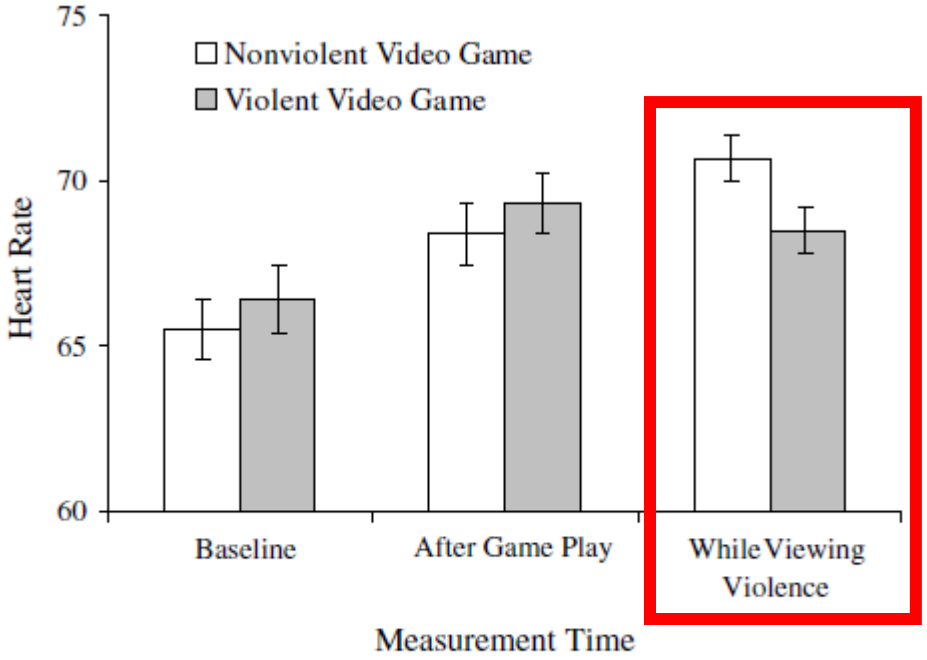

Fig. 2. Heart rate at baseline, after playing a video game, and while watching filmed real-life violence for violent and nonviolent video game players. Capped vertical bars denote 1 SE.

Participants who previously played a violent video game had lower HR while viewing filmed real violence, demonstrating a physiological **desensitization** to violence.

Carnagey et al., (2007). The effect of videogame violence on physiological desensitization to real-life violence. *Journal of Experimental Social Psychology* 43, no. 3, 489–496

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

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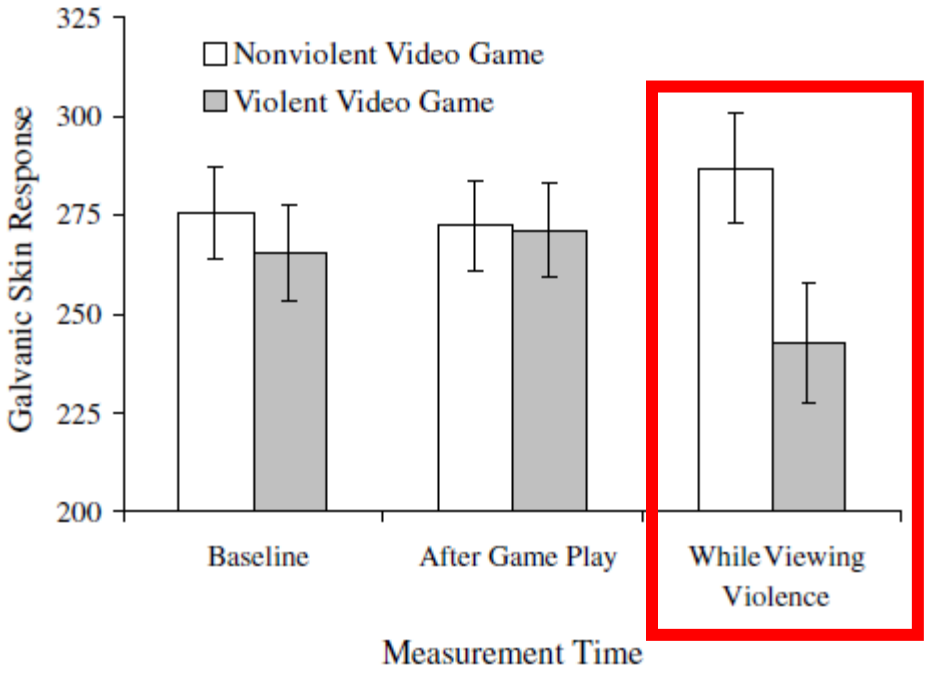

Fig. 3. Galvanic skin response at baseline, after playing a video game, and while watching filmed real-life violence for violent and nonviolent video game players. Means are the adjusted for gender and how frustrating, fun, involving, and fun the video games were. Capped vertical bars denote 1 SE.

Participants who previously played a violent video game had lower GSR while viewing filmed real violence, demonstrating a physiological **desensitization** to violence.

Results are interpreted using an expanded version of the General Aggression Model

Carnagey et al., (2007). The effect of videogame violence on physiological desensitization to real-life violence. *Journal of Experimental Social Psychology* 43, no. 3, 489–496

General Aggression Model

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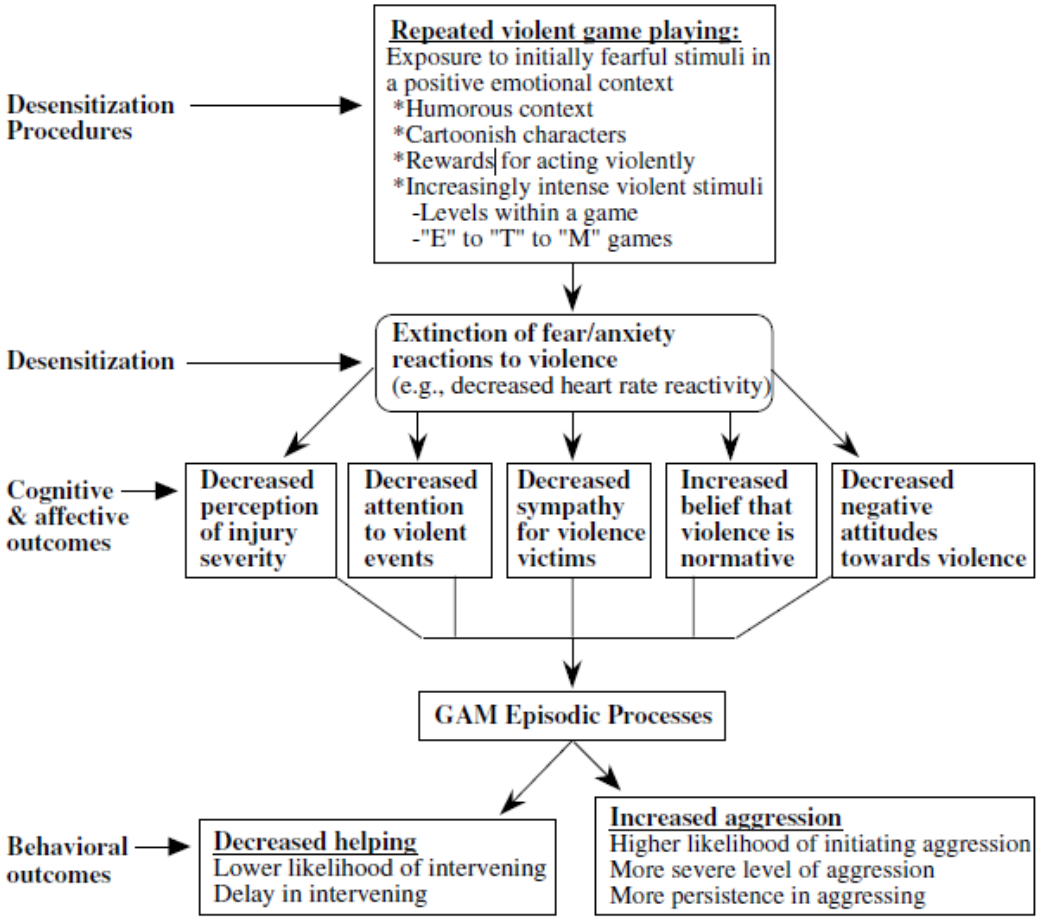


Fig. 1. Media violence desensitization processes: integration of systematic desensitization, helping, and aggression models.

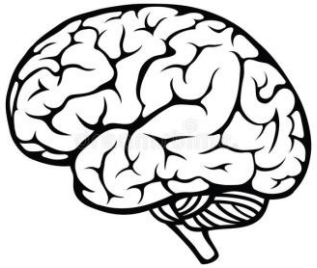
Aggressive behavior is based on the learning, activation, and application of aggression-related knowledge structures stored in memory.
Such learning takes place through encounters with the physical and social world.
Much learning occurs through observing real and fictional characters

Carnagey et al., (2007). The effect of videogame violence on physiological desensitization to real-life violence. *Journal of Experimental Social Psychology* 43, no. 3, 489–496

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

- Playing violent videogames has consequences on our behaviors. What about our **brain**?

behaviors



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• Human Brain Mapping 27:948–956(2006) •

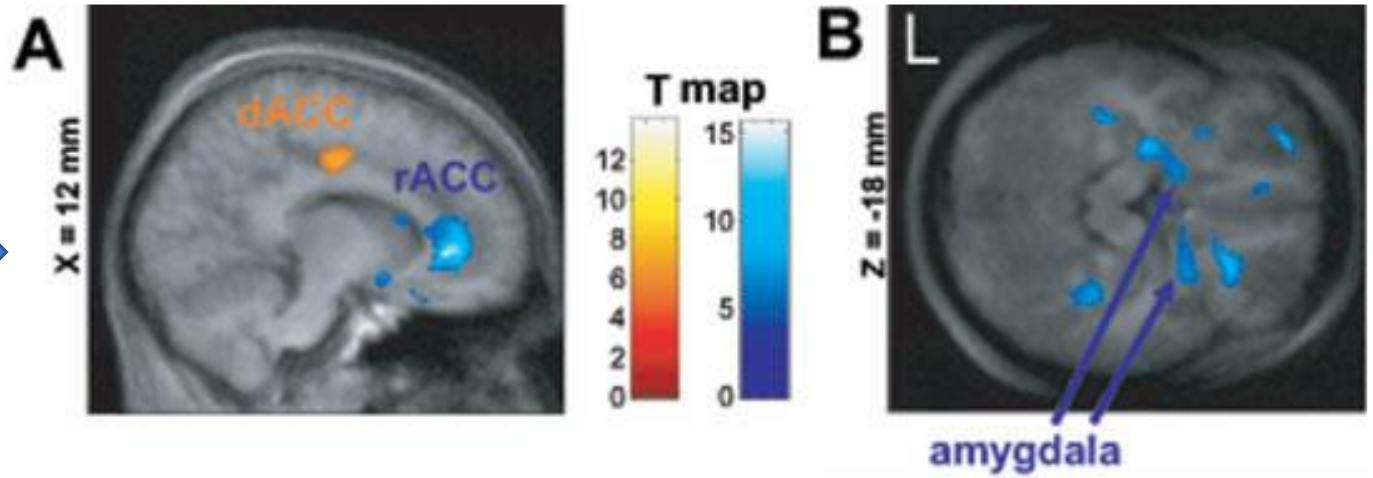
VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

Toward Brain Correlates of Natural Behavior: fMRI during Violent Video Games

Klaus Mathiak[1] and René Weber[2]

[1]Department of Psychiatry & Psychotherapy, RWTH Aachen University, Aachen, Germany
[2]Department of Communication, Michigan State University, East Lansing, Michigan, USA

- N = 13 experienced gamers (18–26 years; average 14 hrs/week playing



- Watching violent scenes caused a change in activity in certain areas of their brains, and specifically one particular area, **the rostral anterior cingulate**. This area is normally active during detection of discrepancies in incoming information, such as in the Stroop test, when reaction time is slower because the name of a color (e.g., blue) is printed in a color not denoted by the name, such as red.

Mathiak et al., (2006). Toward brain correlates of natural behavior: fMRI during violent videogames. *Human Brain Mapping* 27, no. 12, 948–956

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

• Human Brain Mapping 27:948–956(2006) •

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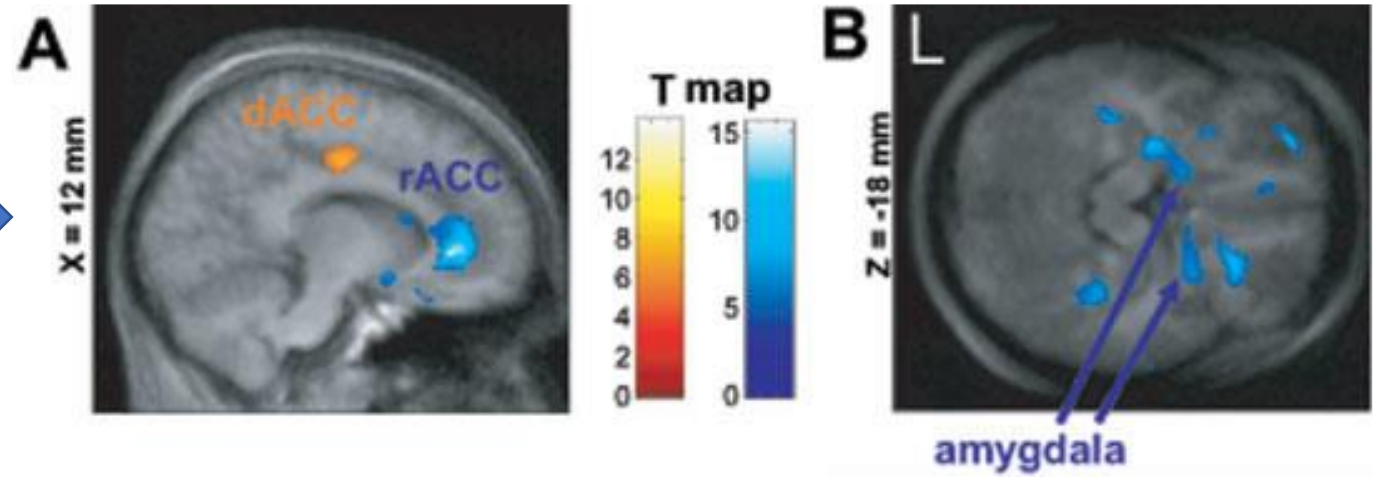

- Gaming was also correlated with the **deactivation of the amygdala**, a brain region normally linked to emotionally charged memory, such that decreased activity in this area would lead to the suppression of fear and an overall drop in emotion.

Mathiak et al., (2006). Toward brain correlates of natural behavior: fMRI during violent videogames. *Human Brain Mapping* 27, no. 12, 948–956

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

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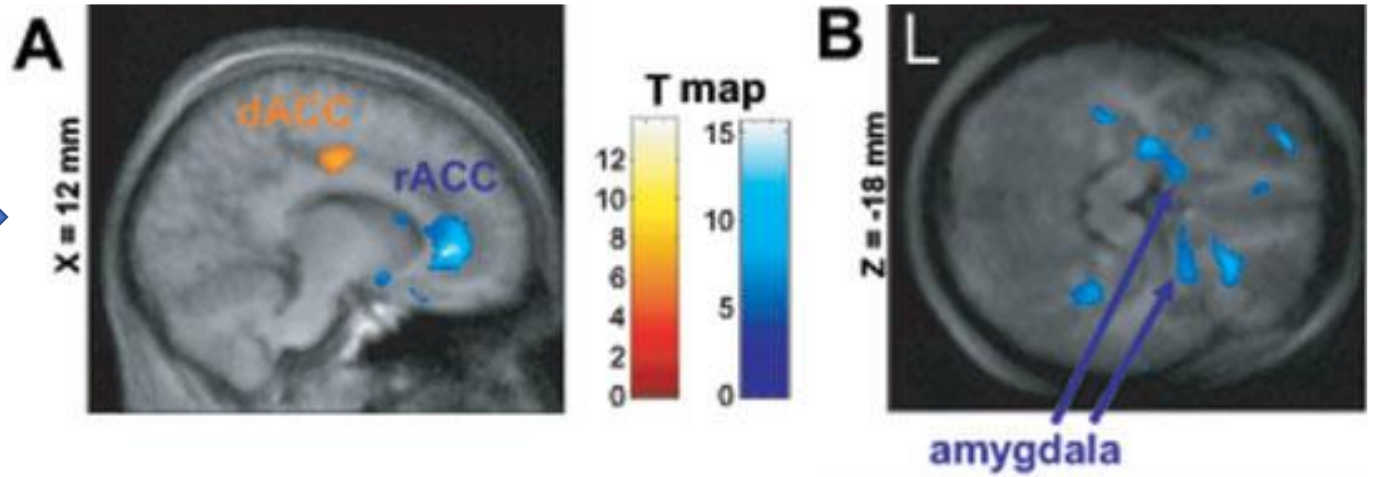


- The brains of the gamers were therefore **less sensitive and less emotionally reactive** to **discrepant** actions, such as sudden violence

Mathiak et al., (2006). Toward brain correlates of natural behavior: fMRI during violent videogames. *Human Brain Mapping* 27, no. 12, 948–956

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

MEDIA PSYCHOLOGY, *8*, 39–60

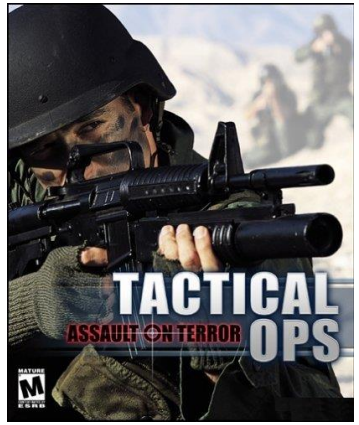
Does Playing Violent Video Games Induce Aggression? Empirical Evidence of a Functional Magnetic Resonance Imaging Study

René Weber
Michigan State University

Ute Ritterfeld
University of Southern California

Klaus Mathiak

- N = 13 male research participants were observed playing a latest-generation violent video game (Tactical Ops: Assault on Terror).



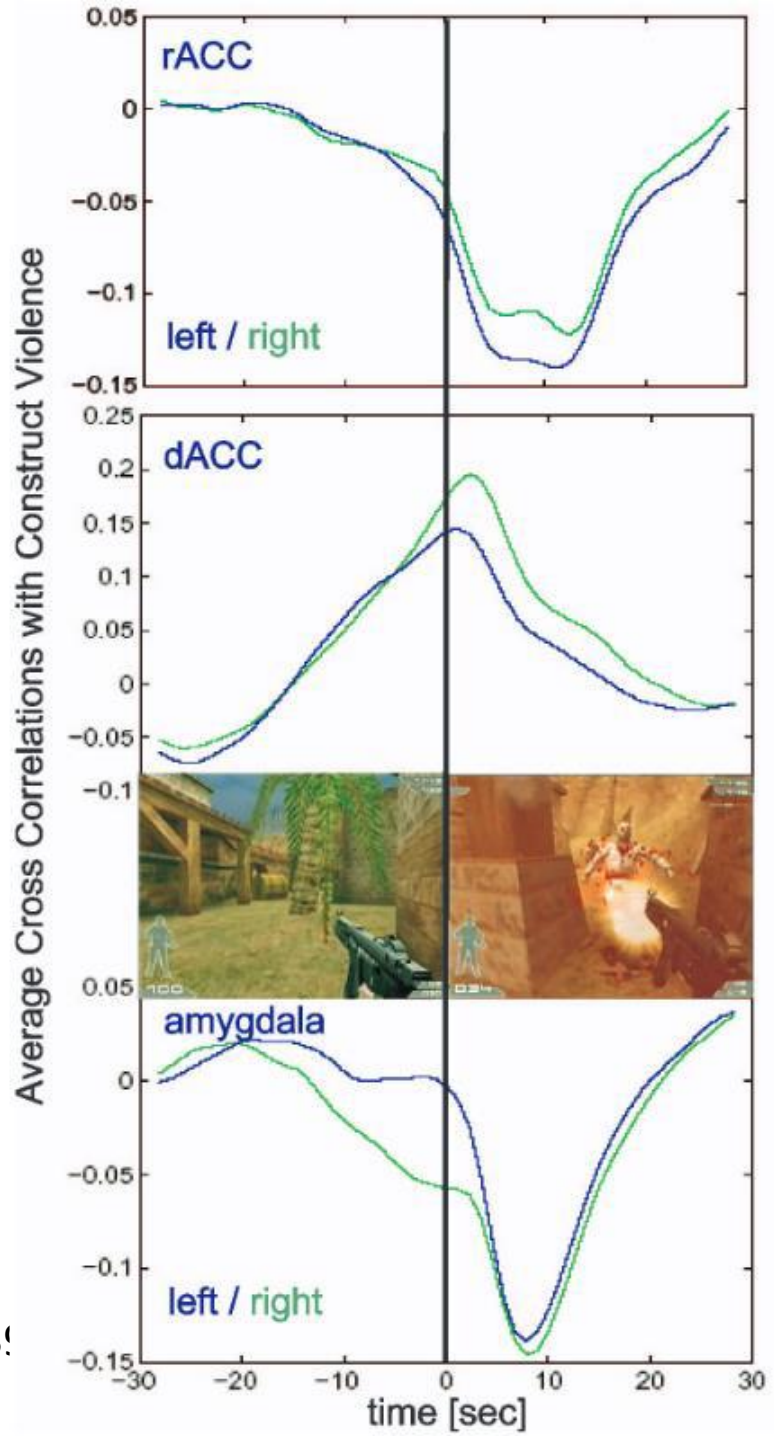
- Each participant's game play was recorded and content analyzed on a frame-by-frame basis. Screen activities were coded as either "passive/dead, no interactions"; "active/safe, no imminent danger/no violent interactions"; "active/potential danger occurs, violent interactions expected"; "active/under attack, some violent interactions"; and "active/fighting and killing, many violent interactions.

Weber et al., (2006). Does playing violent videogames induce aggression? Empirical evidence of a functional magnetic resonance imaging study. *Media Psychology* 8, no. 1, 39–60.

VIDEOGAMES, AGGRESSION, AND RECKLESSNESS

Results:

- Areas of the brain linked with emotion and empathy (again the **rostral cingulate cortex and the amygdala**) were **less active during violent gaming**
- The authors suggest that these areas must be suppressed during violent gaming, just as they would be in real life, in order to act violently without hesitation
- Furthermore, there was activation of areas associated with aggression and cognition, paralleling the activation that occurs during real-life violence.



Weber et al., (2006). Does playing violent videogames induce aggression? Empirical evidence of a functional magnetic resonance imaging study. *Media Psychology* 8, no. 1, 3
60.

From aggression to attention

- Could videogames, given their fast-paced and vivid content, be affecting attention in a way that is unprecedented and unique compared to all the usual, more muted distractions of real life?

- Contrasting results: both positive and negative results…

Videogames and attention

- A sample of 1323 middle childhood participants were assessed during a 13-month period by parent- and child-reported television and video game exposure as well as teacher-reported attention problems.
- Another sample of 210 late adolescent/early adult participants provided self-reports of television exposure, video game exposure, and attention problems.
- Teachers measured attention problems by reporting difficulties the participants had staying on task and paying attention, and whether a child often interrupted another child's work

Swing et al., (2010). Television and videogame exposure and the development of attention problems. *Pediatrics* 126, no. 2, 214–221.

Videogames and attention

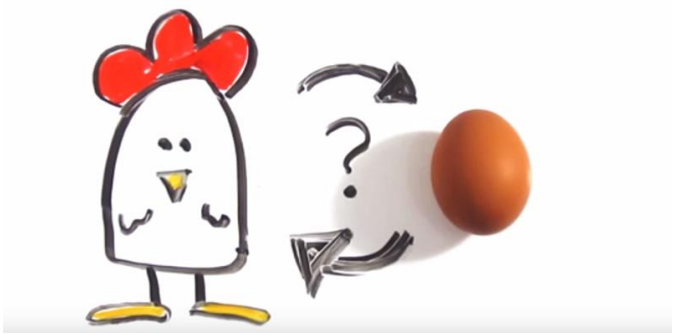
RESULTS:

1) those who had more than **two** hours of screen time (television and videogames combined) **per day** were more likely to be above the norm in showing attention problems.
2) playing games was linked specifically to a greater risk of developing attentional problems, and that it was in fact a more robust predictor than television viewing

Swing et al., (2010). Television and videogame exposure and the development of attention problems. *Pediatrics* 126, no. 2, 214–221.

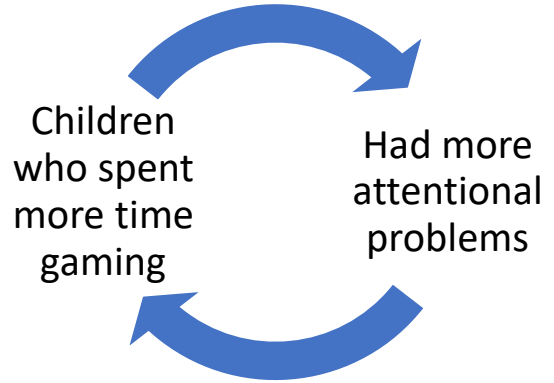
Videogames and attention

- N = 3000 children and adolescents tracked over 3 years



RESULTS:

- Children who spent more time gaming had more attention problems
- Children who were more impulsive or had more attention problems subsequently spent more time playing videogames



Gentile et al., (2012). Videogame playing, attention problems, and impulsiveness: Evidence of bidirectional causality. *Psychology of Popular Media Culture* 1, no. 1, 62.

Something good…

- Research shows that gamers make excellent drone pilots, and even outperform real pilots on certain tasks.
- In the same spirit, scientists at the Duke School of Medicine have investigated just how effectively skilled gamers might eventually become highly proficient drone pilots, compared to their student colleagues who didn't play action games

McKinley et al., (2011). Operator selection for unmanned aerial systems: Comparing videogame players and pilots. *Aviation, Space and Environmental Medicine* 82, no. 6, 635–642.

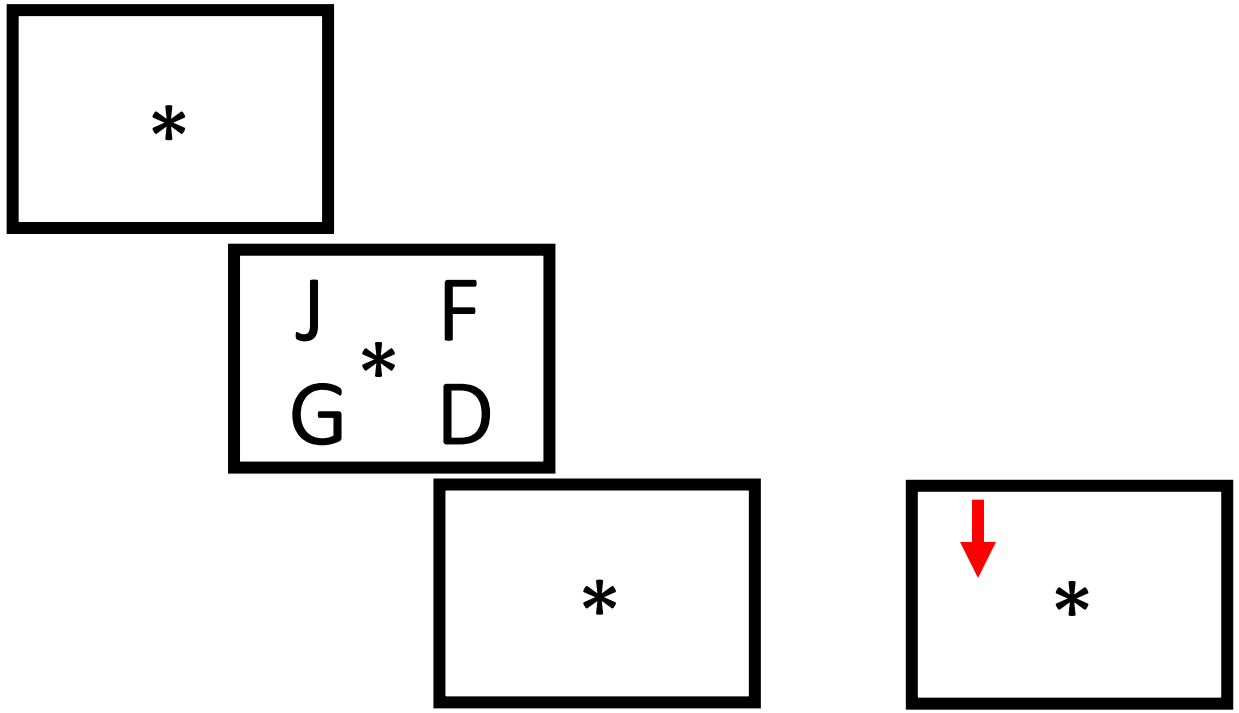
Atten Percept Psychophys (2013) 75:1161–1167
DOI 10.3758/s13414-013-0472-7

Something good…

Action video game playing is associated with improved visual sensitivity, but not alterations in visual sensory memory

L. Gregory Appelbaum · Matthew S. Cain · Elise F. Darling · Stephen R. Mitroff

- N = 130 individuals (18–53 years)
- Divided in 2 groups:
  - Action video game players
  - Non video game players
- Task: identify letters in specific positions of the screen



Appelbaum et al., (2013). Action videogame playing is associated with improved visual sensitivity, but not alterations in visual sensory memory. *Attention, Perception, & Psychophysics* 75, no. 6, 1161–1167.

Atten Percept Psychophys (2013) 75:1161–1167
DOI 10.3758/s13414-013-0472-7

Something good…

- The experienced gamers beat their rookie counterparts, proving that they could respond to visual stimuli much more quickly
- *"Gamers see the world differently. They are able to extract more information from a visual scene," Appelbaum concludes. "They need less information to arrive at a probabilistic conclusion, and they do it faster."*

Action video game playing is associated with improved visual sensitivity, but not alterations in visual sensory memory

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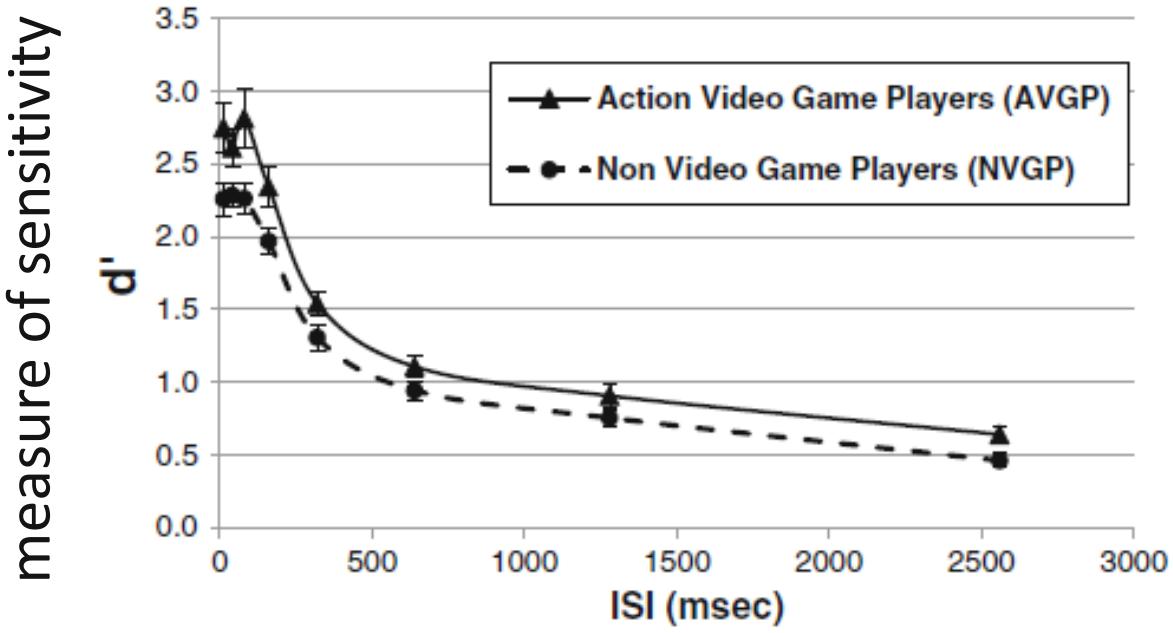


Screen and visual attention

- They were interested in whether learning could improve performance in different tasks other than those on which the training was focused
- Subjects were aged between 18 and 23 years. Divided in 2 groups:

- 5 experiments:
  - experiment 1–4 included only males
  - in experiment 5, both male and female NVGPs underwent training

Action video game modifies visual selective attention

C. Shawn Green & Daphne Bavelier

Department of Brain and Cognitive Sciences, Center for Visual Science, University of Rochester, Rochester, New York 14627, USA

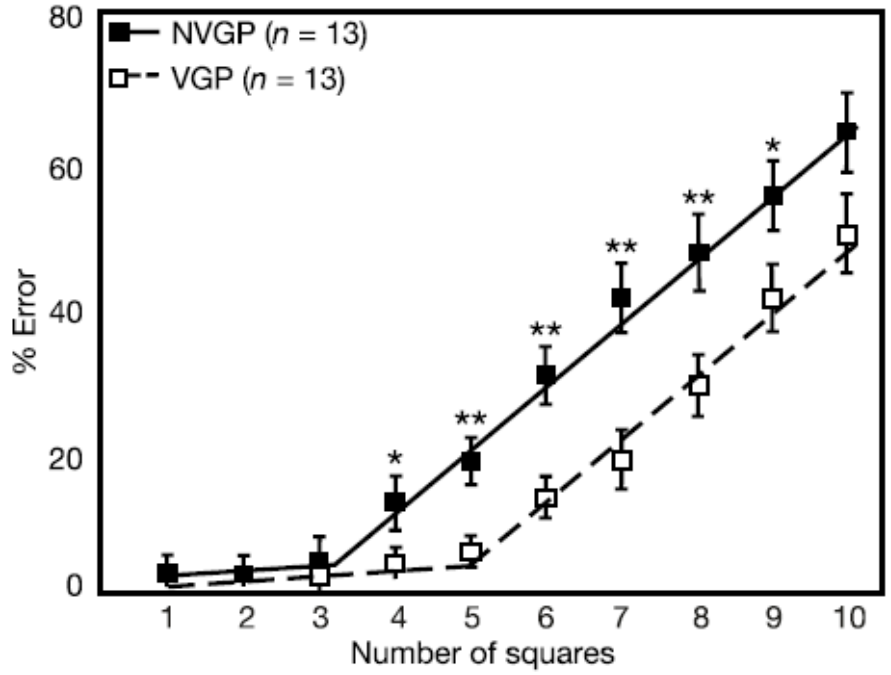
The **Video Game Players** (VGPs) had played action video games on at least 4 days per week for a minimum of 1 h per day for the previous 6 months. Videogames: Grand Theft Auto3, Half-Life, Counter-Strike, Crazy Taxi, Team Fortress Classic, 007, Spider-Man, Halo, Marvel vs Capcom, Rogue speare and Super Mario Cart

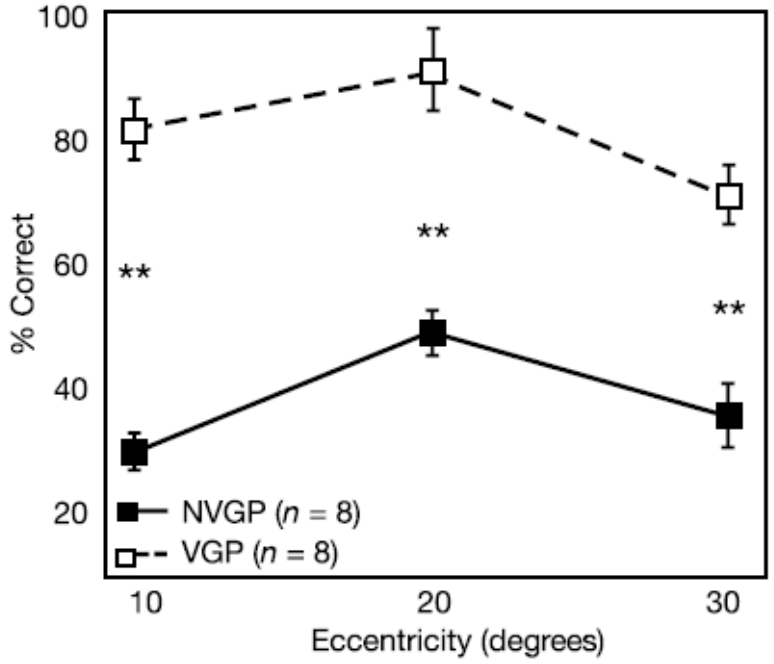
The **No Video Game Players** (NVGPs) had little, and preferably no, video-game usage in the past 6 months.

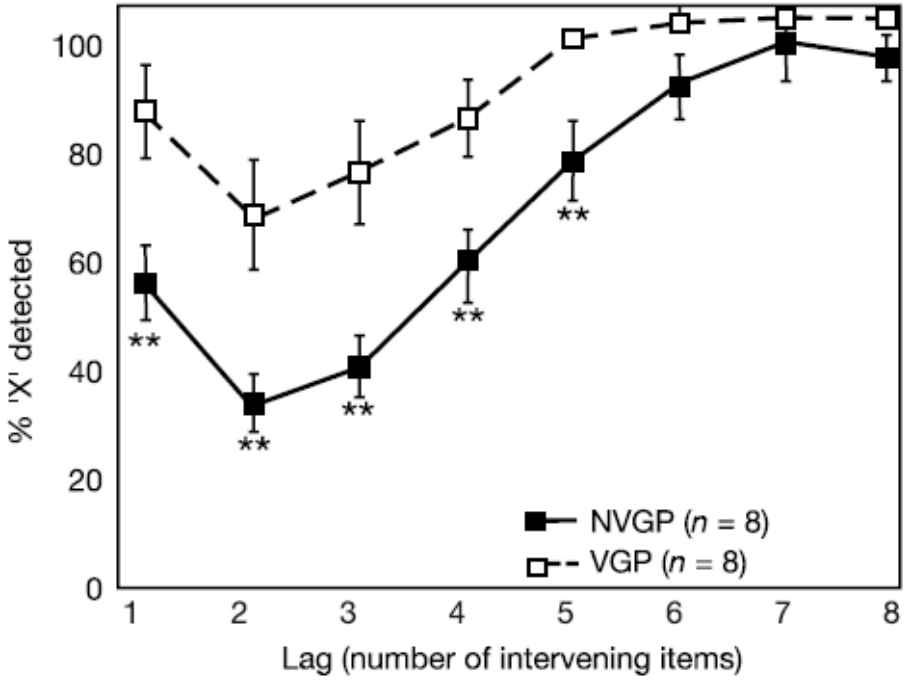
Green and Bavelier (2003). Action videogame modifies visual selective attention. *Nature* 423, no. 6939, 534–537.

Screen and visual attention

the habitual videogame players (VGPs) outperformed the rookies (NVGPs)

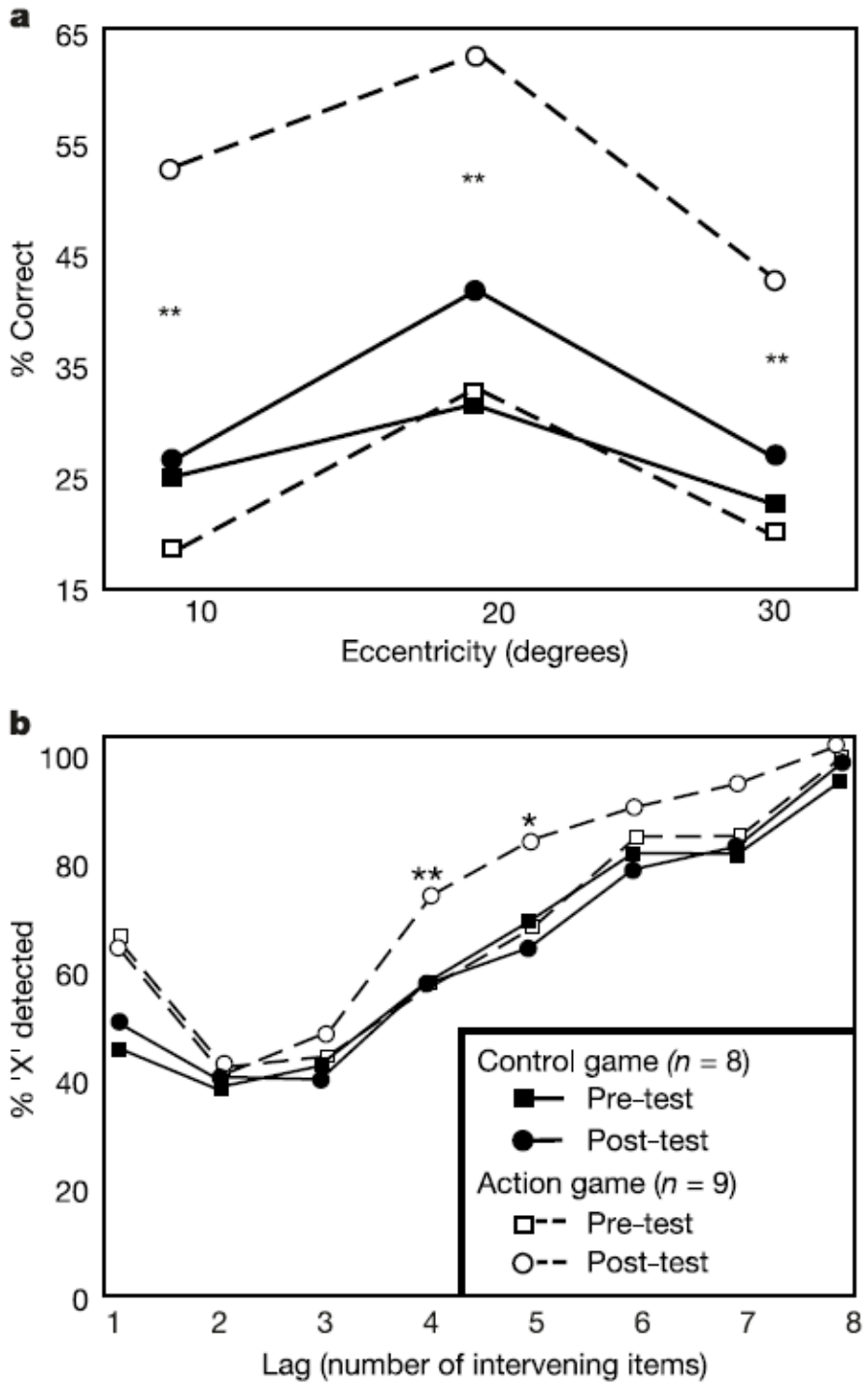






Screen and visual attention

- Most significant, however, was that in a final experiment (experiment 5) the nonplayers who had been subsequently trained on an action videogame showed a marked improvement that transferred to skills well beyond the training task



Green and Bavelier (2003). Action videogame modifies visual selective attention.

Screen and visual attention

- The evidence is convincing that games can have beneficial, remedial effects over a wide range of impairments, including a reversal of cognitive decline in the elderly.

- In one study, the researchers trained older adults in a videogame for a total of 23.5 hours. They assessed their subjects with a battery of cognitive tasks, including tests for executive control and visuo-spatial skills, before, during, and after videogame training.
- The subjects improved significantly within the game but, most important, also showed clear improvement in executive control functions, such as task switching, working memory, short-term visual memory, and reasoning.

Boot, W. R., Blakely, D. P., and Simons, D. J. (2011). Do action videogames improve perception and cognition? Frontiers in Psychology 2, 1–6. doi:10:3389/fpsyg.2011:00226.

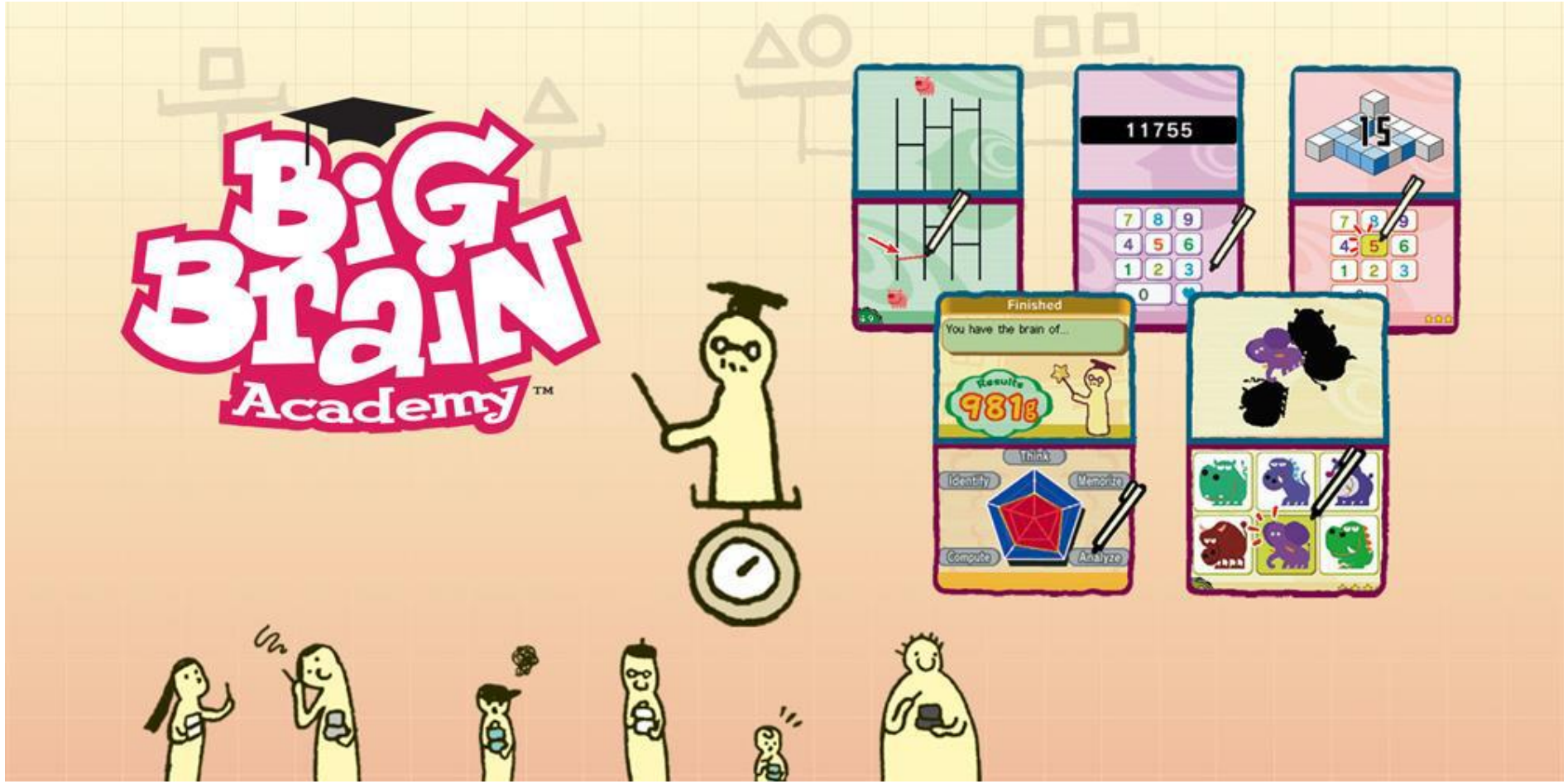
Screen and visual attention

Playing videogames could also potentially have positive effects on more abstract aspects of brain function, such as social development and psychological well-being. For example:

1. Ability to see details
2. Fast processing of fast presented information
3. Improved short memory
4. Improved capacity to process simultaneously
5. Flexibility to change from one task to another

Green, C. S., and Bavelier, D. (2003). Action videogame modifies visual selective attention. Nature 423no. 6939, 534–537
Green and Bavelier (2007). Action-video-game experience alters the spatial resolution of vision. *Psychological Science* 18, 88–94.
Green, C. S., and Bavelier (2012). Learning, attentional control, and action videogames. *Current Biology* 22, no. 6, R197–R206.
Green, Pouget and Bavelier (2010). Improved probabilistic inference as a general learning mechanism with action videogames. *Current Biology* 20, 1573–1579.
Rosser et al., (2007). The impact of videogames on training surgeons in the 21st century. Archives of Surgery 142, no. 2, 181–186

Screen and visual attention



Conclusions on attention

- Selective attention → ability to focus on a specific category of stimuli. This attention is driven by motivation and leads to reactive control (respond to different stimuli presented in the same time)

- Sustained attention → ability to focus for a prolonged period

  This attention leads to proactive control (respond constantly to stimuli presented over time)

Videogame players often respond to fast stimuli → no advantage in Sustained attention

Bailey et al., (2010). A negative association between videogame experience and proactive cognitive control. *Psychophysiology* 47, no. 1, 34–42.